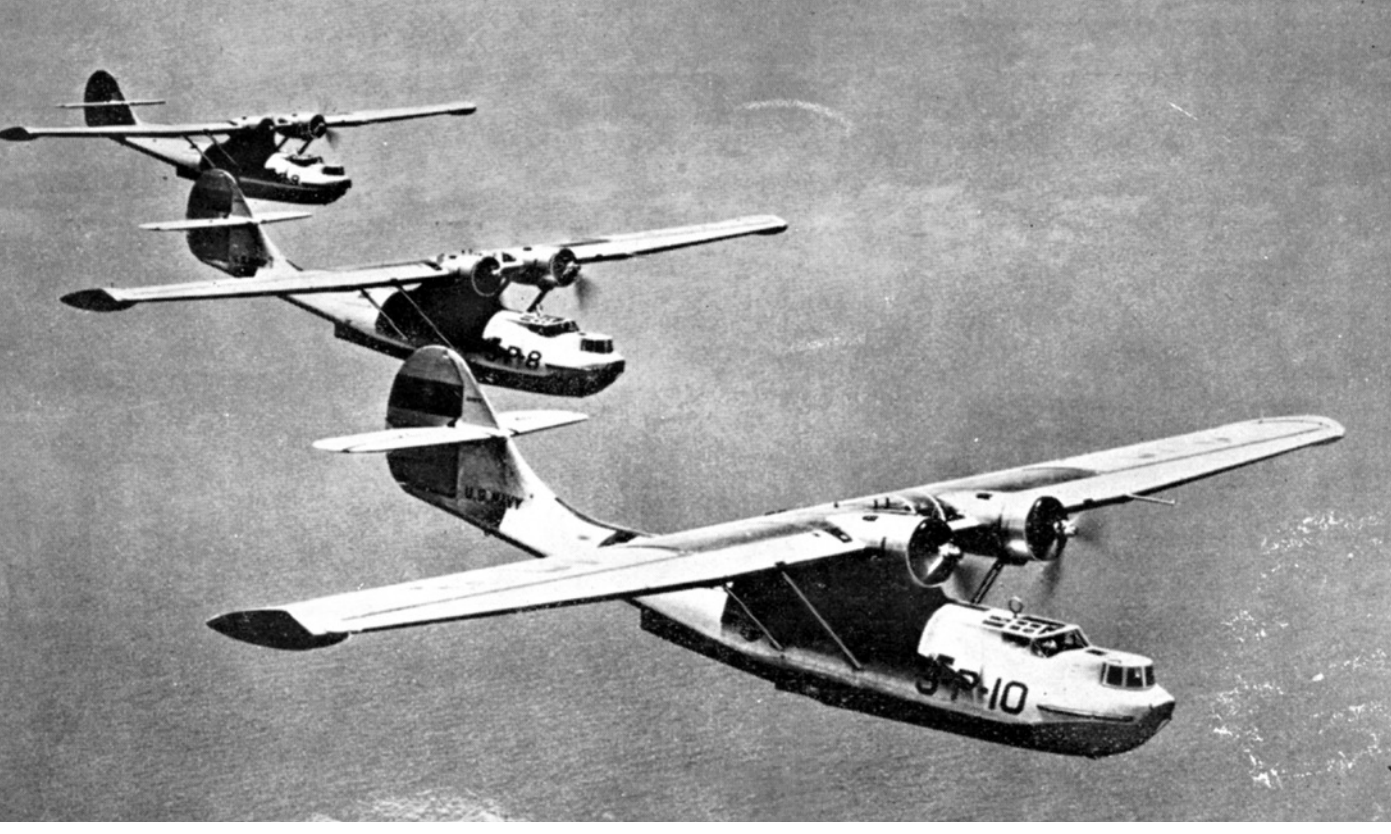
AIR CAMPAIGN

BATTLE OF THE ATLANTIC 1942–45

The climax of World War II's greatest naval campaign

MARK LARDAS | ILLUSTRATED BY EDOUARD A. GROULT



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INTRODUCTION

A Helldiver dive bomber guards a convoy off Norfolk, Virginia. While unsuitable for long-range convoy support, single-engine carrier aircraft operating from land bases could protect convoys as they formed or dispersed outside ports. (AC)

In his six-volume series *The Second World War*, Winston Churchill wrote, 'The only thing that ever really frightened me during the war was the U-boat peril.'

By the start of 1942, two things were obvious: the U-boat presented a deadly peril to Great Britain's survival and Allied victory, and aircraft were the most effective tool for stopping U-boats. Both sides spent the first two years of the war squandering their advantages in the Battle of the Atlantic. Germany never built up U-boat numbers to decisive totals, while Britain neglected Coastal Command. Until January 1941 it lacked weapons capable of reliably sinking U-boats. Even after getting the weapons, aircraft inventories were kept at starvation levels and inadequate numbers were available for the tasks to be done. It was not that Britain lacked aircraft capable of maritime patrol, rather, those aircraft were assigned to other tasks, largely Bomber Command, not the maritime Coastal Command.

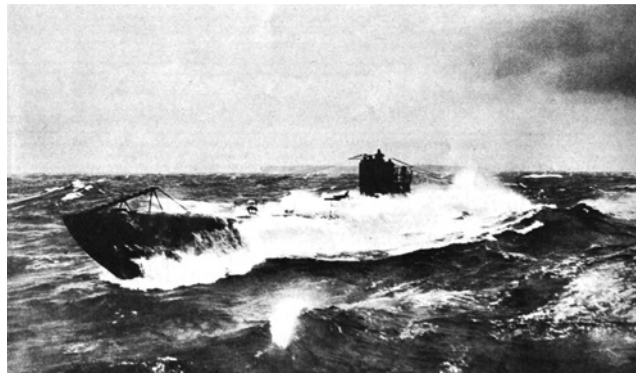
Yet as 1942 opened it seemed these problems were in the past, for both sides.

Germany had 91 operational U-boats, and over 150 in training or trials. Annual production for 1942–44 was planned to exceed 200 boats. In 1939 Karl Dönitz, running the Kriegsmarine's U-boat arm, projected he needed 300 U-boats in commission to knock Britain out of the war. It looked like he would finally have the numbers needed to run the tonnage war he wanted against the Allies.

Britain, though, had finally assembled the solution to the U-boat peril. Its weapons systems and detection systems had improved to the stage that maritime patrol aircraft could launch deadly attacks. In the closing days of December 1941, a Swordfish torpedo bomber, re-equipped for anti-submarine patrol, found a U-boat using radar, and sunk it at night. Darkness no longer shielded U-boats. Also in December, an escort carrier and very-long-range (VLR) aircraft from Ireland had prevented a U-boat pack and Luftwaffe Condors from savaging a homeward-bound convoy from Gibraltar. In a first in a protracted convoy battle, fewer Allied ships were sunk than U-boats.

Britain even gained a major ally: the United States, who entered the war following Japan's attack on the US Navy's base at Pearl Harbor on 7 December 1941. By 11 December, a mutual exchange

of declarations of war between Germany and the United States had drawn the Americans into the Battle of the Atlantic. The industrial might of the United States, larger than the combined economies of all of the other Allies – or the combined economies of all Axis powers – was to be brought to bear on Germany.



German U-boats threatened Britain's connection with its supply lines. Their strength lay in finding weak spots in Allied anti-submarine defences, and attacking at those points. Anything unguarded was at risk to these sea wolves. (AC)

Unfortunately, the American entry into the war expanded the battlefield. The last time the battlefield expanded significantly, after France fell in the summer of 1940, the U-boats were able to flank the British. The first 'Happy Time' resulted. U-boats tore into inadequately protected merchant vessels, both those in convoys and sailing independently. It took Britain nine months to end the U-boat rampage.

This time it would take longer to bring the situation under control. Hitler had kept Dönitz and his U-boats out of the western half of the Atlantic Ocean for fear of bringing the United States into alliance with Great Britain. With the US now allied with Britain, there was nothing to keep U-boats out of American waters, and almost nothing to stop them operating there.

The United States was ill-prepared to counter the U-boat threat. There was no counterpart to Britain's Coastal Command in either the United States Army or Navy. The Navy could use its long-range patrol squadrons for anti-submarine duties. These operated the long-range amphibian Catalina and Mariner flying boats, but most immediately available squadrons were already committed to stations in Iceland and Newfoundland. New squadrons had to be raised. The Army employed medium bomber squadrons on anti-submarine patrol, but the crews were untrained in attacking submarines.

Nor could the Navy immediately supply much in the way of surface escorts. It was fighting a naval war on the other side of the world with Japan, and needed every warship there. US Navy doctrine held that an inadequately defended convoy was worse than no convoy. Time would provide escorts, but until then merchant ships proceeded along America's Gulf and Atlantic coasts individually and unescorted.

This meant vast, heavily travelled areas of the oceans existed with only token protection available against U-boats – that a solution existed for the U-boat peril mattered little where the solution was unavailable. While those fields were far removed from the U-boats' bases, they were within reach, and Dönitz sent his U-boats to those areas. A second 'Happy Time', similar to the first, resulted.

Over the next year a vicious game of hide-and-seek was played in the Atlantic Ocean and surrounding waters. The U-boats hid in under-patrolled waters, seeking merchant shipping to sink. As the Allies filled one area with anti-submarine forces, especially aircraft, the Germans moved to new areas. When unprotected areas no longer existed, the U-boats challenged the escorts in what Dönitz believed would be overwhelming numbers.

To the U-boat skippers it did not matter what was sunk. As long as the tonnage sunk exceeded the tonnage of shipping added by new construction, Germany would win. By August 1942, Dönitz had enough operational U-boats to keep 100 at sea at any given time and could flood any under-protected area with U-boats.

As assiduously as Dönitz probed weak spots, the Allies plugged the gaps in their protection, especially air coverage. Escort numbers increased, patrol aircraft multiplied and air gaps were filled by new airfields. Finally, in the broad reaches of the Atlantic, too far for shore-based maritime patrol aircraft to effectively cover, escort carrier groups provided an air umbrella. No matter how hard he tried, Dönitz could find no way for his U-boats to counter aircraft. This book tells what happened.

CHRONOLOGY

1935

18 June Anglo-German Naval Treaty signed, permitting Germany to build U-boats.

29 June Kriegsmarine commissions U-1, its first U-boat.

1936

14 July Coastal Command established.

12 August U-27, the first Type VII U-boat, commissioned.

1939

24 August Coastal Command begins patrols of the North Sea.

25 August Dönitz sends U-boats into the Atlantic in anticipation of the start of World War II.

1 September Germany invades Poland.

3 September Britain and France declare war on Germany.

17 September HMS *Courageous* sunk by U-29 while on anti-submarine patrol in the Western Approaches.

1940

January Mk I air-to-surface radar first used on Coastal Command aircraft.

30 January First U-boat 'kill' credited to aircraft, when a No. 228 Squadron Sunderland forces the previously damaged U-55 to scuttle.

9 April Germany invades Denmark and Norway.

13 April Britain occupies the Faeroe Islands.

19 April Germans begin operating U-boats from Norwegian ports.

22 June France surrenders. Germany occupies the northern and maritime provinces of France.

July Mk II ASV radar enters operation.

7 July U-boats begin operating out of French Atlantic ports, with the arrival of U-30 at Lorient.

17 August Hitler declares a total blockade of the British Isles. Unrestricted submarine warfare begins.

September Construction of first French submarine pens completed.

U-boat command headquarters moves to Paris.

FW-200 Condors begin anti-shipping and maritime reconnaissance operations out of Bordeaux.

Leigh light developed.

November U-boat command headquarters moves to Lorient.

1941

January Germans begin building reinforced bunkers (submarine pens) at French ports.

23 January 250lb depth charge available for use.

15 April The Royal Navy assumes operational control of Coastal Command.

May Barrier patrols initiated in Bay of Biscay and Iceland/Faeroes gap.

2 June No. 120 Squadron, equipped with Liberators, established at RAF Nutts Corner, Northern Ireland.

7 July Defence of Iceland transferred to the United States.

August United States sends VP-73 to Iceland, begins anti-U-boat patrols in Neutrality Zone.

30 November A Coastal Command Whitley on Bay of Biscay patrol makes first successful radar-guided attack on a U-boat, damaging U-71.

7 December United States attacked by Japan at Pearl Harbor and other places in the Pacific.

11 December Germany declares war on the United States.

21 December U-451 sunk off Tangiers by a No. 812 Squadron Swordfish in the first successful radar-guided night attack.

1942

12 January Operation *Paukenschlag*, the first attack by U-boats on the American coast, when U-123 sinks the unescorted cargo ship *Cyclops*.

February German U-boats begin using four-rotor Enigma cypher machines. Allies can no longer read U-boat radio traffic.

March U-boat headquarters moves from Lorient to Paris following the Allied raid at St Nazaire.

1 March U-656 becomes the first U-boat sunk by a US aircraft, depth-charged by a US Navy Hudson operating out of Newfoundland.

1 April First coastal convoys along American coast begin.

July Wideawake Field in Ascension Island opens.

4 July Convoy PQ-17 scatters, leading to the loss of 24 ships, the highest loss of any convoy in World War II.

August Metox radar detector introduced.

22 August Brazil declares war on Germany.

27 August The first convoy in the Interlocking Convoy System sails.

15 October Army Air Force (AAF) forms Antisubmarine Command.

1943

30 January Erich Raeder resigns as Supreme Commander of the Kriegsmarine. Dönitz replaces him.

5 February Allies crack four-rotor Enigma cryptography. Begin reading U-boat radio traffic again.

February Sir John C. Slessor becomes Commander-in-Chief, Coastal Command.

1–12 March Atlantic Convoy Conference held in Washington DC.

20 March Air Marshal Slessor opens the Bay Offensive against U-boats in the Bay of Biscay.

1 May Admiral Ernest King creates the 10th Fleet, consisting of all anti-submarine activities of the US Navy in the Atlantic.

12 May U-456 becomes the first U-boat sunk by a Fido homing torpedo.

23 May U-752 becomes the first U-boat sunk by rockets.

24 May Dönitz withdraws U-boats from the North Atlantic.

July Ju-88s begin fighter sweeps in the Bay of Biscay, attempting to drive off Coastal Command aircraft.

Soon after the U-boats found a weak spot, the Allies worked to plug it. This often involved posting aircraft at inhospitable locations, such as basing PBY Catalinas at Greenland in 1943. These aircraft were withdrawn when better bases became available. (USNHHC)

August Portugal agrees to let Britain base Coastal Command aircraft in the Azores.

1 August *Zaunkönig* (wren) German homing torpedo introduced.

3 August Use of Metox ordered suspended by U-boat headquarters.

October Coastal Command squadrons begin operating out of Lagens Field in the Azores.

8 October Army Air Force disbands Antisubmarine Command.

1944

January US aircraft begin operating out of the Azores.

20 April U-2501, Germany's first Type XXI U-boat is launched.

6 June Allied invasion of France begins.

7 August Brest abandoned as a U-boat base.

23 September Last U-boat leaves a French port on an operational mission. Subsequent arrivals and departures represent resupply missions of besieged ports.

1945

9 March U-2321 starts its first combat patrol, becoming the first Type XXIII U-boat to enter combat. On a 36-day patrol it sinks one ship for 1,406 tons.

30 April Dönitz replaces Adolf Hitler as head of the Third Reich.

U-2511 departs on its first combat patrol, bound for the Caribbean, the first Type XXI to enter combat. It surrenders at war's end without sinking any ships.

8 May Germany surrenders. War in Europe (and Battle of the Atlantic) ends.

23 May Third Reich dissolved by the Allies; Dönitz arrested.

29 May Blackout in Atlantic Ocean ends. Ship navigation lights again used.

17 August U-997, the last U-boat still at sea, arrives in Argentina and surrenders.

ATTACKER'S CAPABILITIES

The anti-submarine aircraft comes of age

Aircraft

Three broad categories of aircraft fought in the Battle of the Atlantic: multi-engine landplanes, seaplanes and carrier aircraft. Additionally, the US Navy used blimps. Multi-engine landplanes were used for long-range maritime patrol, although some were long-range fighters intended to protect the patrol aircraft. They required prepared runways to operate out of; paved runways for the four-engine aircraft. The seaplanes, amphibians and flying boats, could operate out of sheltered water; they could not operate safely on open water. The carrier aircraft were all short-ranged, single-engine bombers and fighters operating off aircraft carriers.

The line between bombers and fighters was often blurred. Fighters, even single-engine fighters, had the capability to attack ships and U-boats, especially after air-to-ground rockets were introduced in 1943. Anti-shipping was an auxiliary mission for long-range fighters on hunting patrols. Patrol bombers also occasionally hunted enemy aircraft – if a four-engine Liberator encountered a FW-200 Condor for example, the Liberator would often attack the Condor.

Aircraft listed are the major types used by the Allies during 1942 through 1945. Other aircraft used in the early phase of the war such as the Stranraer and Anson were being retired but were still in use.

Blimps, Catalinas and (as shown in this picture) the B-18 Bolo mounted Magnetic Anomaly Detectors. They could fly at the slow speeds and low altitudes MAD required. Because MAD measured magnetic deviations, it was housed in a shroud behind the end of the fuselage. (USAF)

Land-based planes

Lockheed Hudson and Ventura: The twin-engine Lockheed Hudson was Coastal Command's main anti-submarine aircraft in 1940 and 1941. By mid-1942, it was being phased out in favour of more capable aircraft, including its larger and similar-looking cousin, the Ventura. Both were twin-engine military modifications of Lockheed airliners: Lockheed's Model 14 Super Electra for the Hudson, and Model 18 Lodestar for the Ventura. Both were used by Coastal Command, the Army Air Force (AAF) and the US Navy.

The Hudson carried 1,000lb of bombs, cruised at 165 knots and had a six-hour endurance with a range of 1,000nm (nautical miles). Venturas carried up to 3,000lb of bombs and

The Vickers Wellington started the war as Bomber Command's principal heavy bomber. By 1942, superseded by four-engine heavy bombers, it was increasingly used in an anti-submarine role. This is a Mark XIV Wellington built for ASW. It has Mark III radar under the nose, a retractable Leigh light in the bomb bay and carried up to eight depth charges. (AC)

cruised at 192 knots for 7.25 hours with a 1,400nm range. Hudsons ended the war having killed or sharing credit for killing 25 U-boats by war's end; Venturas sank or shared credit for seven U-boats.

Wellington, Whitley, Hampden, Warwick: The first three were twin-engine RAF medium bombers developed in the mid-1930s, and were Bomber Command's front-line bombers when the war began. By 1942 new, four-engine heavy bombers superseded their Bomber Command roles, and these older aircraft were shifted to other duties, including maritime patrol. The Warwick, a Wellington replacement that first flew in April 1942, proved unsatisfactory as a bomber. Warwicks were shifted to maritime patrol and air-sea rescue. All had long range (over 1,400nm), could carry at least 4,000lb of bombs and had space for radar and Leigh lights. Coastal Command started 1942 with 11 squadrons equipped with these aircraft, some on loan from Bomber Command. By 1945 they were credited with destroying 32 U-boats, with 27 sunk by Wellingtons.

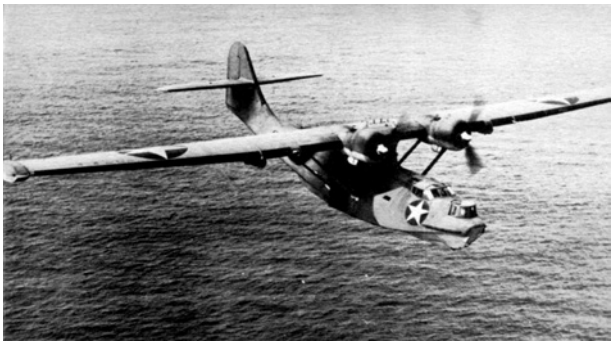
Liberator: The Consolidated Liberator was a four-engine bomber built in the United States. It had a range of 1,800nm. A VLR (very-long-range) version (modified with extra fuel tanks) available in 1943 could reach 2,700nm. Both carried 2,700lb of bombs that distance, and were capable of staying aloft 10–15 hours. It was heavily armed; with 14 .303 machine guns in British versions and ten .50-calibre machine guns in US service. Later, some were armed with rockets. It could be fitted with radar and Leigh lights, had space for relief crew and was easy to fly once airborne. The ideal maritime patrol aircraft, it was also an ideal day bomber (with a bombload of 8,000lb).

In wrestling matches with Bomber Command, Coastal Command almost always lost until Bomber Command decided Liberators were unsuitable for night bombing in 1941. By January 1942, Coastal Command had one squadron of Liberators. These quickly grew. By March 1943 there were four, and by January 1944, six. These were not the only Liberators in the fight, however. Both the Army Air Force (B-24) and US Navy (PB4Y) committed Liberator squadrons, including several squadrons stationed at Dunkswell, Devon. Liberators served the Royal Canadian Air Force maritime patrol squadrons and served throughout the Atlantic theatre. Liberators would sink or assist in sinking 72 U-boats between 1942 and 1945.

Fortress, Halifax: Both aircraft were four-engine heavy bombers used by Coastal Command as maritime patrol aircraft; neither were used for maritime patrol by the United States. As with the Liberator, the Fortress was a US export, rejected by Bomber Command as unsuitable for night bombing. Known in the United States as the B-17 Flying Fortress, it was the US Army Air Force's best-known heavy bomber during its daylight strategic bombing campaign in Europe. The Handley-Page Halifax was one of two heavy bombers

Bomber Command used for its night campaign, and through 1943 Bomber Command was unwilling to part with any.

Both were ideal maritime patrol aircraft. The first Fortress squadron became operational in the autumn of 1941, operating out of Nutts Corner in Northern Ireland. The first Halifax squadron entered service in January 1943. Due to Coastal Command's preference for Liberators and Bomber Command's reluctance to release Halifaxes from strategic bombing, relatively few saw anti-submarine service. Coastal Command had a maximum of three Fortress squadrons and two Halifax squadrons. Despite small numbers, 11 U-boats were lost to Fortresses and three to Halifaxes.



The Consolidated Catalina was the most widely used and successful Allied seaplane in the Battle of the Atlantic. It served in the RAF's Coastal Command, the RCAF, United States Navy and the Brazilian Air Force during the war. Canada built these aircraft under licence, calling their domestically produced version the Canso. (AC)

Beaufighter, Mosquito: Both were twin-engine fighter-bombers. The Bristol Beaufighter was developed from the Bristol Beaufort torpedo bomber. The de Havilland Mosquito emerged from an effort to build a high-speed bomber from non-strategic materials, and proved to be the most versatile aircraft of World War II. Beaufighters replaced the inadequate Blenheim as Coastal Command's long-range fighter, and the Beaufort for anti-shipping. Supplemented by the Mosquito in both roles starting in early 1943, these aircraft were used to counter the increasing threat long-range Luftwaffe fighters and Kriegsmarine patrol craft posed to Coastal Command's maritime patrol aircraft.

Carrier operations

The escort carrier proved the final piece needed in Allied efforts to contain U-boats. Carrier groups could operate anywhere in the Atlantic, providing air coverage in areas out of range of shore-based patrol aircraft. Assigned to a convoy hard-pressed by a U-boat wolf pack, an escort carrier could provide air support and, once the threat was dealt with and the formerly threatened convoy within shore-based coverage, the carrier group could shift to protect a new convoy.

In addition to sinking U-boats dawdling on the surface, carrier aircraft forced U-boats under water, breaking up the ability of a wolf pack to coordinate attacks. They could also direct escort warships to submerged U-boats, often ensuring they never resurfaced.

HMS *Archer* was one of two Allied escort carriers on anti-submarine duty in the North Atlantic in early 1943. *Archer* was a sister ship to *Long Island*, the US Navy's first escort carrier. Both were converted from existing fast cargo ships. They were unique in not having an island – a superstructure to the right of the flight deck, used to control operations. Furthermore, *Archer* had diesel engines, unusual in a large warship in 1941–42, which caused trouble for the rest of its career.

Archer spent most of 1942 and early 1943 ferrying aircraft, or in dockyards repairing its unreliable machinery. Finally, in May 1943, *Archer* was assigned convoy escort duty. Joining the 4th Escort Group, and carrying nine Martlets of No. 892 Squadron and nine Swordfish of No. 819 Squadron, on 9 May, *Archer* sailed on convoy support duties.

After accompanying westbound Convoys ONS-6 and ON-182 across the Atlantic, on 21 May the 4th Escort Group, with *Archer*, joined up with the Britain-bound HX-239. While covering HX-239, one of *Archer*'s Swordfish armed with rocket-spears (solid-fuel rockets with an armour-piercing steel warhead) found and sank U-752 with them.

This plate shows that aircraft, G-for-George of FAA No. 819 Squadron, as it takes off from *Archer*. Two more Swordfish on the flight deck aft of the elevator await their turn to launch. Within an hour, history will be made as the Swordfish makes the first of many U-boat kills with rocket projectiles.

It would be *Archer*'s first and only U-boat kill. *Archer* escorted only one more convoy during its career, covering Convoy KMS 18B, a slow convoy from Britain to the Mediterranean, from 26 June to 3 July. Thereafter *Archer* was withdrawn from the 4th Escort Group and sent on anti-submarine duties in the Bay of Biscay.

However, *Archer* was withdrawn after a week because of engine trouble again. Sent to the Clyde for engine repairs, *Archer* was found to have more problems. It was decommissioned in November 1943, and served as a storage ship and barracks ship for nearly a year. In August 1944, *Archer* went through another round of engine repairs, which were completed in March 1945. Thereafter it served as an aircraft ferry.

B-18 Bolo, B-25 Mitchell: The Douglas Bolo and B-25 Mitchell were Army Air Force twin-engine medium bombers. Through 1943 the AAF used both for anti-submarine patrol, especially off the US Atlantic coast and in the Caribbean. The Bolo, obsolete in 1942, proved useful against U-boats. Over a hundred were fitted with Magnetic Anomaly Detectors (MAD) and retro bombs – retro-firing depth charges. The Mitchell was initially flown by Army pilots with limited over-water experience and no anti-shipping training. Bolos sank three U-boats; Mitchells one.

Seaplanes

Sunderland: The Short Sunderland was a four-engine monoplane flying boat that entered service in September 1938. Designed for maritime patrol, it carried up to 2,000lb of bombs or depth charges in an internal bomb bay and was heavily armed, carrying 16 .303 and two .50-calibre machine guns. With a range of 1,700nm, it could remain aloft for nearly 13 hours.

The Sunderland was one of Britain's most capable anti-submarine aircraft. At the start of 1942, six squadrons were equipped with Sunderlands, but had only 24 available. Even in 1944, with over 80 Sunderlands assigned to squadrons, only 26 were available for duty. Sunderlands were credited with the destruction of 24 U-boats between 1942 and 1945.

Catalina: The Consolidated Catalina was the US Navy's standard patrol bomber in 1942, and was extensively used by the US Navy and Coastal Command. A twin-engine, parasol-wing flying boat; later versions were amphibious, capable of landing on land or water. Slow, with a cruising speed of 125mph and with a very long range (2,100nm), it was extremely reliable. Capable of carrying 4,000lb of bombs, depth charges or torpedoes, British versions were armed with seven .303 machine guns, and US versions with three .30-calibre and two .50-calibre machine guns. The Catalina could also be equipped with radar, MAD and backwards-firing rockets. A Canadian-built version, the Canso, was used by the Royal Canadian Air Force. Catalinas were extremely effective anti-submarine aircraft, and sank 37 U-boats between 1942 and 1945.

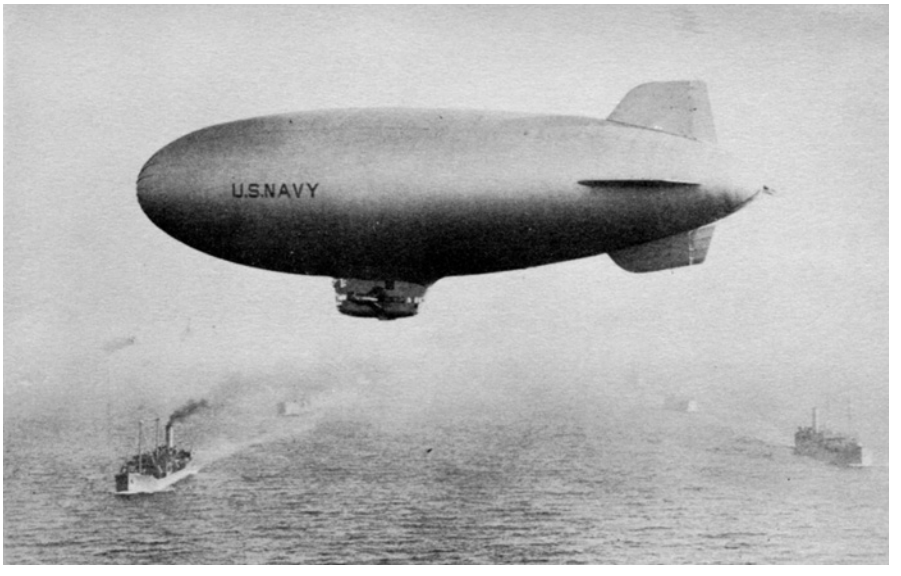
Mariner: The Martin Mariner was a twin-engine flying boat, intended as a Catalina replacement. Instead, the Mariner supplemented the Catalina. While possessing longer range and a heavier payload than the Catalina, early model Mariners were underpowered until the PBM-3D with 1,900hp engines went into production. The US Navy fielded 13 Mariner squadrons during the Battle of the Atlantic (mainly in the Gulf of Mexico, Caribbean and South Atlantic). Coastal Command fielded one. Mariners sank or assisted in sinking ten U-boats.

Carrier aircraft

Between 1942 and 1945, the Fleet Air Arm (FAA) and US Navy used three carrier aircraft to fight U-boats: the Fairey Swordfish, the Grumman F4F Wildcat/Martlet and the Grumman TBF/TBM Avenger. Other aircraft were occasionally used, such as the Sea Hurricane and Seafire fighters, as well as the Fairey Barracuda torpedo bombers by the FAA, but the anti-submarine escort carriers (both British and US) primarily used Swordfish, Wildcats and Avengers.

The Fairey Swordfish: An open-cockpit, single-engine biplane that, despite its antiquated appearance, was deadly against U-boats. It could carry ASV (air-to-surface vessel) radar and 1,000lb of munitions, including rockets, and could operate from carriers or land bases such as Gibraltar. Swordfish sank 20 U-boats between 1942 and 1945. They were used exclusively by the Fleet Air Arm.

The Grumman F4F Wildcat/Martlet: The US Navy's first-line carrier fighter at the beginning of 1942; replaced by the F6F Hellcat in 1943, it continued to be used in the Atlantic, where the air threat was limited. Britain purchased some prior to American entry



One unusual weapon fielded against U-boats by the US Navy was blimps, armed with depth charges and equipped with radar and MAD. They sank no U-boats, and resources used to build and deploy them might have been more useful elsewhere, but the United States could afford experiments. (AC)

into the war as Martlets. Wildcats had four .50-calibre machine guns capable of damaging a U-boat. Used aboard escort carriers, Martlets and Wildcats contributed to sinking 26 U-boats during 1942–45.

The Grumman Avenger: A mid-wing, single-engine torpedo bomber. It could carry one torpedo, up to four depth charges or two Fido homing torpedoes in its internal bomb bay. It had a range of 1,000nm. The Avenger entered service in early 1942, and was used extensively aboard escort carriers in the Atlantic by both the Royal Navy and the US Navy. Avengers sank or participated in the sinking of 35 U-boats during World War II.

Blimps

The US Navy made extensive use of lighter-than-air, helium-filled non-rigid airships in the Battle of the Atlantic, deploying squadrons in the Gulf of Mexico, the Caribbean, the central Atlantic Ocean area and the Mediterranean. Blimps had an extremely long endurance, allowing them to pin down a submarine, but were vulnerable to anti-aircraft fire due to their low speed and large size. They rarely attacked, but rather called other resources, warships and aircraft, to dispose of the U-boats. They could detect and attack submerged U-boats, as they carried depth charges, and many were equipped with MAD. They were also used to find and recover shipwreck survivors.

The main type used in the Atlantic was the K class, of which 134 were built before and during World War II. These were 251ft 8in long with a diameter of 57ft 10in. They cruised at 48 knots, had an endurance of 26 hours and a range of 1,840nm. They could carry four depth charges, had a single .50-calibre machine gun mounted in a bow turret on the gondola and removable mountings for Browning Automatic Rifles aft.

Facilities and infrastructure

Airfields, command structure, aircraft and munitions industries, and logistics comprise the aerial anti-U-boat infrastructure. Airfield location effectively defined the reach of aircraft; command structure controlled deployment; the aircraft industry produced the machines to conduct the campaign; and logistics (including flight crew training) controlled available resources provided to fighting forces. Throughout the first two years of the Battle of the Atlantic, Coastal Command and the Fleet Air Arm had adequate airfields, command structure

and logistics support, but what they lacked were resources: aircraft, weapons and personnel.

However, in 1941 a new factor entered the battlefield: the United States. Its effects cannot be understated. Before World War II the economy of the United States was bigger than the combined economies of all Axis nations, including the economies of the nations conquered by the Axis – even with the US economy slack due to the Depression. Britain, fighting alone in 1940, had been out-produced two-to-one by the European Axis nations. Even after Russia's entry in 1941, the Allies only gained parity with the European Axis. Suddenly, with the entry of the US, the balance abruptly shifted two-to-one in the other direction. By 1945, the US economy, spurred by wartime production, nearly doubled, as Axis production shrank.

This meant that logistics and production were no longer long-term problems for the Allies. Once production accelerated there would be enough aircraft and weapons for even low-priority organisations, like Coastal Command, to receive much-needed resources. Difficulties, however, remained in getting what was needed, where it was needed, when it was needed, especially in 1942 and the first half of 1943.

In January 1942, the Allies had a sufficient airfield structure to fight the war of 1941; a war fought in the eastern half of the Atlantic Ocean. Coastal Command had 20 airfields in the British Isles, with airbases in Iceland, Gibraltar and West Africa. These included seaplane bases, and airfields with paved runways for land-based aircraft. All had facilities to arm, fuel and service patrol aircraft.

The US entry into the war expanded the battlefield dramatically. The Allies needed to cover not only the western Atlantic, but also areas in the middle of the ocean previously untravelled by convoys, especially after the invasion of North Africa in November 1942 increased shipping across the Atlantic to the Mediterranean.

The Royal Canadian Air Force had airfields in Newfoundland and Labrador used for maritime patrol, and Britain also had bases in the Caribbean and Bermuda. The United States had a network of airfields and seaplane bases along the American coast from which maritime patrol craft could operate. Additionally, the Destroyers for Bases Agreement of September 1940, in which Britain exchanged airfields and naval bases in Newfoundland, the Bahamas, Jamaica, Antigua, Trinidad and British Guiana for 50 US destroyers, gave the US facilities to operate aircraft there.

Initially, except at Argentia, Newfoundland and Reykjavík, Iceland, the US had not deployed anti-submarine squadrons before January 1942. These and RCAF aircraft patrolling Canada's Atlantic coast were the only anti-submarine aircraft squadrons covering the western Atlantic.

Gaps were filled during the first nine months of 1942. The Allies discovered the Germans had shifted U-boats to areas without air cover. This forced the construction of new airfields in locations where airfields were unavailable: Greenland, Brazil, Ascension Island in the South Atlantic, and finally the Azores.

The United States' industry and manpower gave the Allies the ability to quickly expand or create airfields, a capability it began providing before formally entering the war. Here, Army personnel build airfield facilities at Reykjavík in late 1941. (USAF)

This took time, but the industrial capacity of the US assured it could be done. The US started construction on airfields and facilities in Iceland prior to American entry into the war. Surveys were done and construction started in Greenland in 1941. While two airfields were operational in early 1942, the critical Bluie East 2, near Greenland's eastern coast and filling a gap between Iceland and Newfoundland, was not completed until 1943.

To expand air coverage over South America, the US received permission to use and improve airfields in neutral Brazil in early 1942. It had previously acquired

rights to use airfields in Belém and Natal for ferry flights. By March 1942, US Navy patrol squadrons were operating out of Brazil's Parnamirim Field at Natal, and by 1943 US patrol squadrons were operating out of ten different airfields and seaplane bases in Brazil. After Brazil declared war on the Axis in August 1942, Brazilian Air Force aircraft took part of the anti-U-boat patrol responsibilities.

The United States obtained the use of airfields throughout North and South America between July 1941 and July 1942. It was operating aircraft, including anti-submarine aircraft, at Brazil's Parnamirim Field in Natal by June 1942, before Brazil's active entry into the Allied coalition. (USAF)

Harder to fill were mid-Atlantic gaps. One was plugged in mid-1942 when the US finished construction of Wideawake airfield on Ascension Island. This covered a gap in the South Atlantic, between Africa and Brazil. While built by the US, both British and US aircraft operated from it, with the first aircraft, a Swordfish, landing there in June 1942.

More difficult to cover was the central part of the southern North Atlantic. The Azores, controlled by neutral Portugal, were best positioned to cover this part of the Atlantic. The Allies considered invading the Azores, which the Portuguese garrisoned during the war, but diplomacy prevailed. In August 1943, Britain invoked the Anglo-Portuguese Alliance of 1373, and Portugal agreed to permit Britain to base forces on the Azores, including airfields on Terceira and São Miguel islands. Coastal Command began operating from it in October 1943.

By January 1944 the Allies had fixed bases for aircraft to operate from where they could patrol most of the Atlantic convoy routes. The US had also built a chain of blimp bases from Lakehurst, New Jersey to Brownsville, Texas, across the Caribbean, down the South American coast from Colombia to Recife, Brazil, as well as Fernando do Noronha, Morocco, Gibraltar and the Mediterranean. Aircraft carriers and seaplane tenders proved another way to base aircraft.

The Royal Navy largely abandoned seaplane tenders after the creation of the RAF, although Coastal Command had two depot ships, SS *Manella* and SS *Dumana* to support seaplanes. The US Navy, however, used seaplane tenders extensively to provide mobile bases for seaplane patrol squadrons. Most tenders were vessels converted from minesweepers or destroyers, which provided the capability to operate a patrol at unimproved locations until permanent facilities could be built.

Both the Royal Navy and US Navy had aircraft carriers; their fleet carriers were too few and too valuable to risk on anti-submarine duty. Both navies instead fielded escort carriers as U-boat hunters. These ships, built on merchant hulls between 500ft and 600ft long, displaced 14,000–20,000 tons, could steam 20 knots and carried 20–30 aircraft. The Royal Navy and US Navy each commissioned their first escort carrier in June 1941, HMS *Audacity* and USS *Long Island* respectively, both converted from merchant ships.

While the first escort carriers, British and US, were merchant conversions (most altered while under construction), the vast majority were laid down as escort carriers. These were the Bogue and Casablanca classes, which used merchant hull designs, but were built as aircraft carriers. They could be mass-produced: there were 43 Bogue-class carriers built between 1941 and 1943 and 50 Casablanca class built between November 1942 and July 1944. In all, the United States built 123 escort carriers during World War II.

Britain received 34 escort carriers from the United States, and built five in British yards. Britain also added flight decks to five grain carriers and 11 tankers. These had top speeds

OPPOSITE AN EYE IN THE SKY: AN ESCORT CARRIER TASK GROUP GUARDS A CONVOY

The Allies quickly learned that escort carrier task groups were most effective when operating independently of convoys. That did not mean they did not protect convoys, rather it meant they were better operating as a distant escort, generally ahead of or to one side of the convoy, removing or neutralising U-boats before the convoy reached where the U-boats were operating. Here is how carrier aircraft guarded convoys against U-boat wolf packs in late 1943 and throughout the rest of the war. There are four basic forms of air coverage for a convoy.

between 11 and 12.5 knots, and carried four aircraft (generally Swordfish) in addition to their cargoes. All served on convoys. In total, 22 Royal Navy and US Navy escort carriers saw service fighting U-boats in the Battle of the Atlantic.

Weapons and tactics

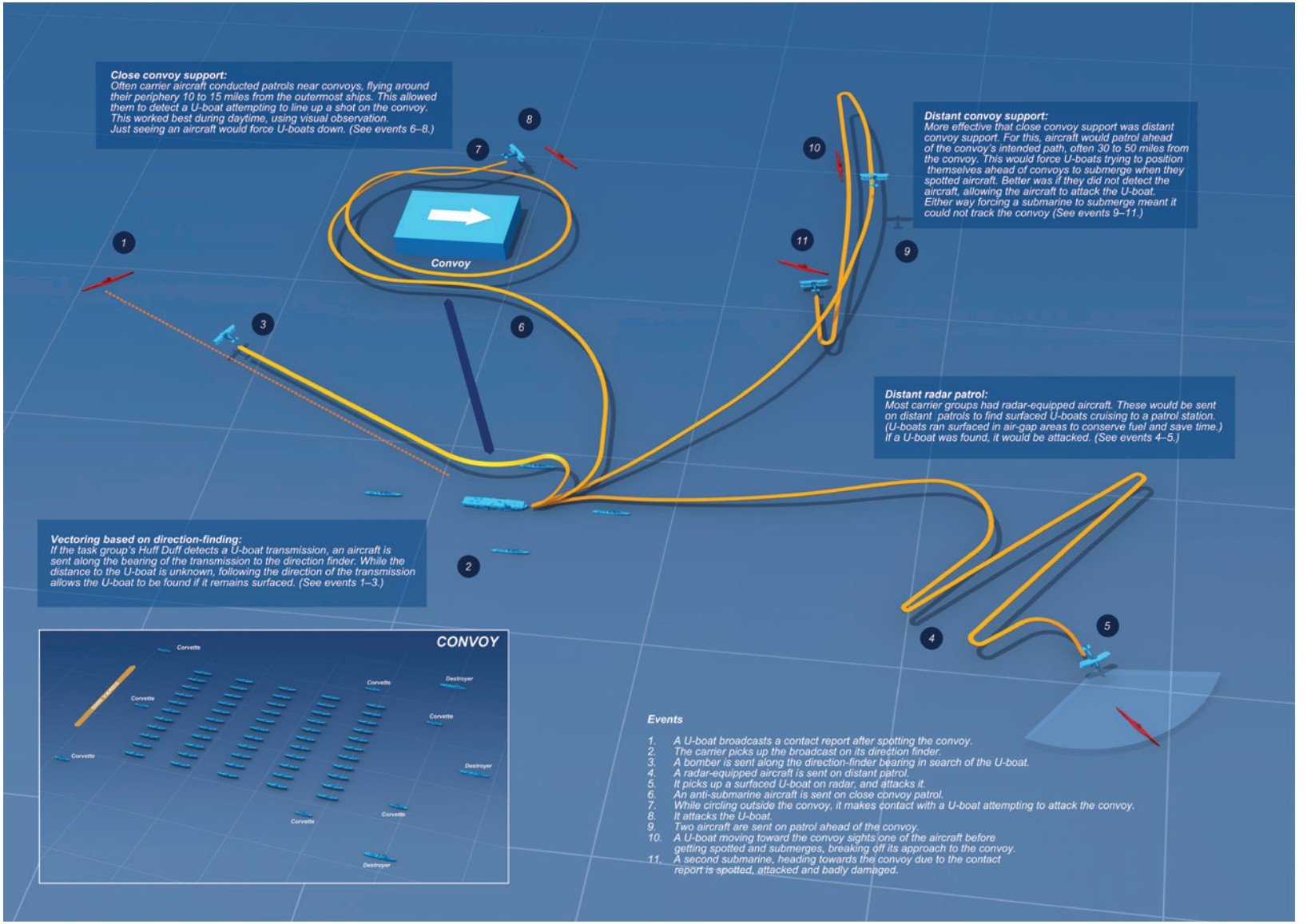
Unlike 1939, the Allies started 1942 with airborne weapons capable of finding, fixing and destroying U-boats. Codebreaking and High Frequency Direction Finding (HF-DF, or huff-duff) allowed aircraft to know where U-boats were lurking to the nautical mile. Radar, the Leigh light, sonobuoys and Magnetic Anomaly Detectors (MAD) permitted aircraft to fix a U-boat's location accurately enough to sink it. Effective weapons, not just depth charges that would kill but new tools that included homing torpedoes and rockets, ensured destruction. Additionally, tactics improved throughout 1942 so that by April 1943 U-boats stood little chance against aircraft.

HMS *Acavus* was one of nine tankers converted to Merchant Aircraft Carriers by Britain. It entered service as a MAC in September 1943, carrying four Swordfish in addition to its normal cargo of black oil. After Germany's surrender it was used as an aircraft ferry in the Far East. (AC)

Electronic intelligence – codebreaking and huff-duff

Even using radar-equipped aircraft, randomly searching the ocean yielded low results. The Allies had two ways to know where U-boats were likely to be: through codebreaking and huff-duff. Both benefited from the high volume of operational U-boat radio traffic. U-boats reported daily to U-boat headquarters in Europe via radio, and often more frequently radioing contact reports – traffic which the Allies could intercept.

Although encoded using the 'unbreakable' Enigma cypher machine, Enigma was broken pre-war by the Poles, who transferred their knowledge to Britain after Poland fell in 1939. Messages sent included U-boat locations, operational orders and rendezvous sites. Decoded


Close convoy support:
Often carrier aircraft conducted patrols near convoys, flying around their periphery 10 to 15 miles from the outermost ships. This allowed them to detect a U-boat attempting to line up a shot on the convoy. This worked best during daytime, using visual observation. Just seeing an aircraft would force U-boats down. (See events 6–8.)
Distant convoy support:
More effective that close convoy support was distant convoy support. For this, aircraft would patrol ahead of the convoy's intended path, often 30 to 50 miles from the convoy. This would force U-boats trying to position themselves ahead of convoys to submerge when they spotted aircraft. Better was if they did not detect the aircraft, allowing the aircraft to attack the U-boat. Either way forcing a submarine to submerge meant it could not track the convoy (See events 9–11.)
Convoy
Distant radar patrol:
Most carrier groups had radar-equipped aircraft. These would be sent on distant patrols to find surfaced U-boats cruising to a patrol station. (U-boats ran surfaced in air-gap areas to conserve fuel and save time.) If a U-boat was found, it would be attacked. (See events 4–5.)
Vectoring based on direction-finding:
If the task group's Huff Duff detects a U-boat transmission, an aircraft is sent along the bearing of the transmission to the direction finder. While the distance to the U-boat is unknown, following the direction of the transmission allows the U-boat to be found if it remains surfaced. (See events 1–3.)
CONVOY
Corvette
Destroyer
Events
1. A U-boat broadcasts a contact report after spotting the convoy.
2. The carrier picks up the broadcast on its direction finder.
3. A bomber is sent along the direction-finder bearing in search of the U-boat.
4. A radar-equipped aircraft is sent on distant patrol.
5. It picks up a surfaced U-boat on radar, and attacks it.
6. An anti-submarine aircraft is sent on close convoy patrol.
7. While circling outside the convoy, it makes contact with a U-boat attempting to attack the convoy.
8. It attacks the U-boat.
9. Two aircraft are sent on patrol ahead of the convoy.
10. A U-boat moving toward the convoy sights one of the aircraft before getting spotted and submerges, breaking off its approach to the convoy.
11. A second submarine, heading towards the convoy due to the contact report is spotted, attacked and badly damaged.

messages allowed the Allies to route convoys around U-boat concentrations, and to direct U-boat hunters, including aircraft, to areas where U-boats were operating.

This was not real-time data. It often took days to decode messages and there were blackout periods when the Germans changed cypher groups and messages could not be read. Codebreaking proved especially valuable in 1943, when it was used to direct the destruction of German supply U-boats, which had to operate in known areas for long periods.

Even during blackout periods, German U-boat transmissions allowed U-boats to be located through huff-duff. This used monitoring stations to track the bearing of radio transmissions relative to the station. By using widely dispersed multiple stations, a U-boat's location could be found by learning where beams crossed. Britain had used shore-based tracking direction-finding stations since the war started, but by the end of 1941 they had placed stations outside Britain, permitting more accurate resolution.

More than that, they were adding huff-duff to ships. While in 1941 only one convoy escort had huff-duff installed, by 1943 all escorts, especially escort carriers, had it. When carriers detected U-boat transmissions, it set anti-submarine aircraft along the broadcast's bearing.

Sensors – radar, Leigh lights, sonobuoys and MAD

Spotting U-boats required sensor systems such as radar, Leigh lights, sonobuoys and MAD. The first two detected surfaced U-boats, the last two could find submerged U-boats.

Radar was the primary tool for detecting U-boats. By January 1942, air-to-surface vessel (ASV) Mark II radar was widespread on British anti-submarine aircraft. It broadcast 1.7m radio waves. It had a maximum range of 36 miles, and at 2,000ft it could reliably detect a surfaced U-boat from 10–15 miles away. It also had a minimum range of 1,000ft – any closer and ground clutter hid the target.

The solution was the Leigh light, a high-power, aimable searchlight mounted on an aircraft's wing or bomb bay. (The US counterpart was the L-7 and L-8 spotlight.) At night, it was switched on when the U-boat disappeared on radar. Large and heavy, it could be installed only on bombers, such as the Wellington or Liberator. Although developed in March 1941, it was only widely deployed in spring 1942.

The ASV Mark II–Leigh light combination was so effective that Germany developed radar detectors to warn when they were in use. The Allies counteracted that with the introduction of centimetre-wave radar, ASV Mark III, which could not be detected by German antennae. It was also more accurate, and proved even deadlier than ASV Mark II. It contained a cavity magnetron, which amplified the signal. Developed by two Scots graduate students, it was shared with the US, which mass-produced it. The US used aircraft equipped with centimetre-wave radar as early as July 1942. Coastal Command only received an adequate number of ASV Mark IIIs in April 1943. Bomber Command grabbed up all of the early deliveries for its H2S navigation radars. Later variants of ASV radars included an attenuator, which reduced signal power and so foiled detectors, and 3cm radar, which could detect a periscope or Schnorchel. It appeared operationally in October 1944.

The Mine-Torpedo Mk 24 was one of the most effective anti-submarine weapons of World War II. An acoustic torpedo, it homed in on the sounds made by a submerged U-boat's engine. Its ability to faithfully follow its prey earned it the nickname 'Fido'. (USNHHC)

To detect submerged U-boats, the Allies developed sonobuoys and Magnetic Anomaly Detectors (MAD). Sonobuoys were air-droppable buoys containing a hydrophone and a radio to transmit sonar echoes to

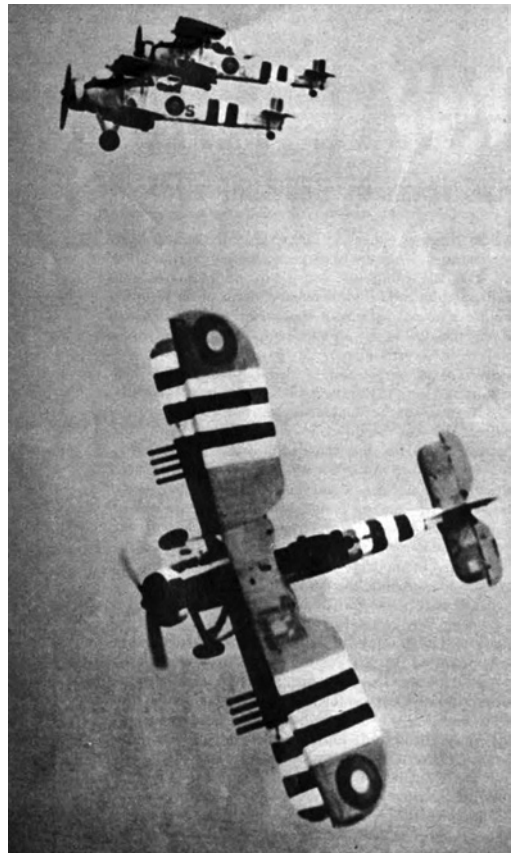
the aircraft dropping it. They could detect a U-boat submerged up to a depth of 60ft and as far away as 3nm. Originally non-directional, later models gave a bearing. Prototypes were tested by the US in 1940, and sonobuoys entered service in spring 1943. Before 1943 ended, Coastal Command was also receiving them.

MAD used compass deviation to detect the presence of large iron-containing objects (such as a steel submarine). The flux a U-boat produced was low and a MAD could only detect U-boats submerged 100ft or less, and only when the aircraft was directly overhead at a maximum altitude of 100ft. It had to be used from slow aircraft, such as Catalinas and blimps, and was frequently used in combination with sonobuoys. MAD entered service in autumn 1942, and was used almost exclusively by the United States.

Weapons – depth charges, acoustic torpedoes, retro-bombs and rockets

By January 1942 the Allies possessed aircraft munitions that killed U-boats. Over the next year they added new and deadlier weapons.

The oldest and most common airborne weapon was the air-dropped depth charge. The British 450lb air-droppable depth charge had been in service since September 1939, but could not be used by smaller aircraft, like Hudsons. Britain also had a 250lb air-droppable depth charge, first fielded in 1941. Filled with TORPEX, these had a lethal radius of 19ft and were often carried in preference to the 450lb depth charge because more could be carried, permitting a wider attack footprint. The US began World War II with the air-droppable Mark 17 325lb depth charge filled with TNT. In 1942, TORPEX replaced TNT, and the 650lb TORPEX-filled Mark 29 depth charge became available in summer 1942.

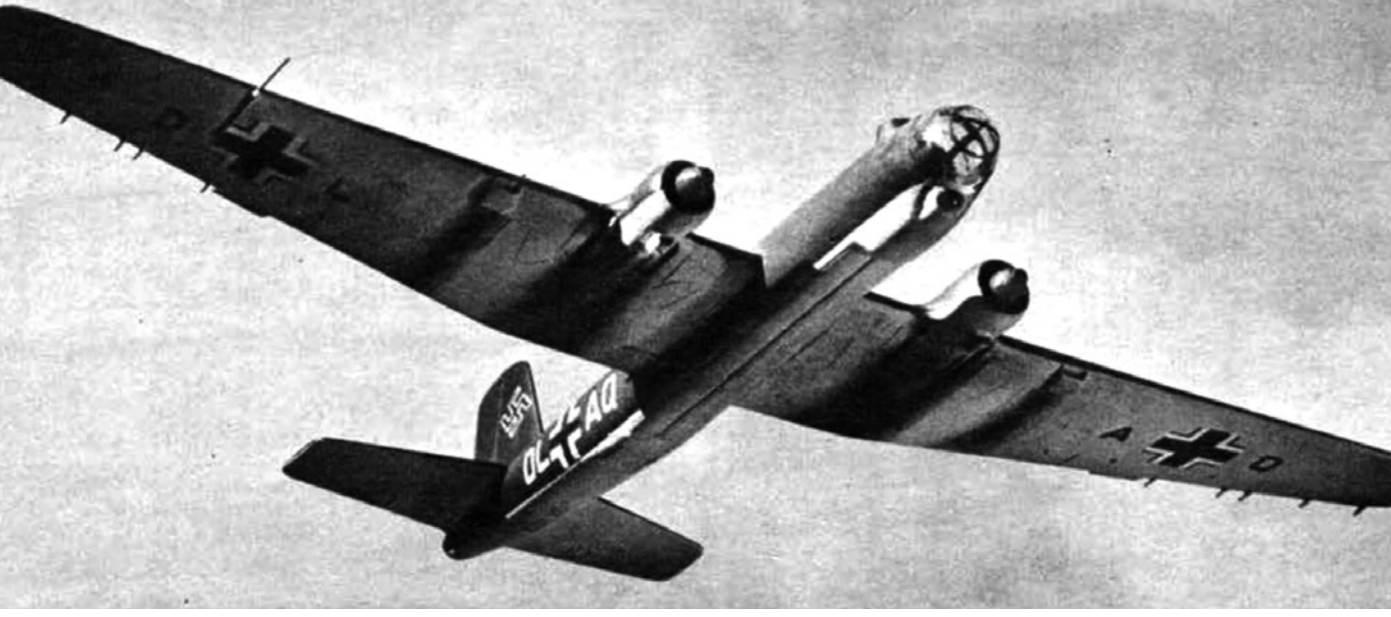


Anti-submarine rockets were introduced in 1943. Used by almost every anti-submarine aircraft, they were first successfully used by Swordfish. This Swordfish flight, equipped with rocket racks, provided anti-submarine protection in English Channel waters during the June 1944 invasion of France. (AC)

In April 1943, the Allies fielded a new weapon: the Mark 24 torpedo. Air dropped using parachute stabilisation, it was an acoustic homing torpedo nicknamed 'Fido'. Once in the water, it followed the noise of a U-boat's propellers and, with a 92lb high-blast explosive warhead, it cracked the U-boat's pressure hull when it hit. A Fido weighed 680lb and could be carried by most anti-submarine aircraft.

One problem with MAD was that aircraft detected the U-boat only when directly overhead. To allow aircraft to hit a U-boat, the US Navy developed a backward-firing "retro-bomb" rocket that carried a 35lb bomb. When fired, the bombs fell straight down, the rockets cancelling the aircraft's forward speed. These were fired in three salvoes of eight, half a second apart. The bombs, contact-fused, exploded if they hit the U-boat, and were powerful enough to crack the pressure hull.

A final weapon introduced in 1943 was the forward-firing rocket. Developed by Britain, it was a solid-fuel anti-tank rocket modified for use against U-boats. Travelling at near-supersonic speed, with a solid steel warhead, it used kinetic energy to crack open a U-boat's pressure hull. Each rocket weighed 66lb, and eight were carried, four under each wing. They were to be fired at a shallow angle, with best results achieved if the rockets entered the water. Due to the warhead shape, they arced up, striking the U-boat at or near the waterline. The first kill with these rockets occurred in May 1943, by a Swordfish. The US adopted the rocket soon after Britain.



DEFENDER'S CAPABILITIES

Hunted hunters

By 1942 new maritime patrol aircraft including the HE-177 (shown) and the Do-290 were appearing. They were used more for reconnaissance and to attack Allied warships aiding Coastal Command aircraft in the Bay of Biscay than to attack merchant shipping. (AC)

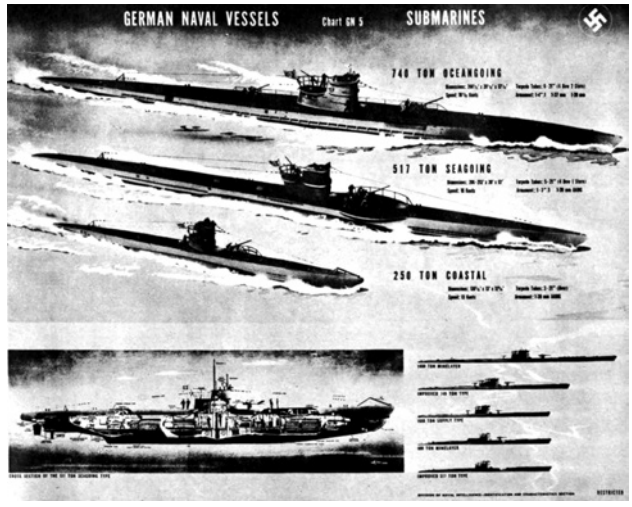
Although Germany was attacking Allied shipping, its U-boats were the defenders in the air campaign. If U-boats were cats hunting mice in the form of cargo ships, maritime patrol aircraft were eagles. While a cat might occasionally prevail against eagles, its best course of action was to hide from them. Surfaced U-boats, or those just below the surface, leave a telltale wake that is easier to spot from the air than the aircraft is to spot from a U-boat. Radar-equipped aircraft could find surfaced U-boats even in darkness – when a U-boat deck watch could not see the aircraft. Its only defence against aircraft was to submerge. But once underwater, it could no longer attack aircraft, only endure attack.

Although Germany seemed to be winning the Battle of the Atlantic in 1941, and appeared to be overwhelming the Allies in 1942, its success hid structural weaknesses in Dönitz's tonnage war. Its resources, in terms of U-boats, aircraft, infrastructure and weapons had severe shortfalls – German victory depended upon Allied mistakes.

The U-boat and Luftwaffe

The two main weapons Germany used against shipping during the Battle of the Atlantic after December 1941 were the U-boat and, to a lesser extent, Luftwaffe aircraft. Surface raiders, conventional warships and disguised raiders, played almost no role in shipping losses. Allied aerial efforts concentrated on seeking out and destroying U-boats, and suppressing Luftwaffe maritime activity.

In the Atlantic, the Germans used two major types of U-boats from 1942 onward: the Type VII and the Type IX. (The Type II boats used in the war's first years had been withdrawn from the Atlantic, though they were still used in the Baltic and the Black Sea.) Several miscellaneous versions, Type XB and Type XIV, minelaying and supply U-boats, which were used as milch cows also saw Atlantic service. Germany also developed Type XXI and Type XXIII 'Electroboot' vessels, and Type XVII and Type XVIII 'Walter' boats.



An identification chart used to familiarise Allied pilots with the appearance of different types of U-boats. The 740-ton oceangoing U-boat is a Type XI, the 517-ton the Type VII and the 250-ton coastal the Type II (withdrawn from the Atlantic by 1942). U-boat variants and the Type X are shown in silhouette on the bottom right. (AC)

Furthermore, a few captured or seized foreign submarines were used on combat patrols. Italy also sent 32 submarines into the Atlantic prior to 1942, but by January 1942 only 12 remained in the Atlantic. Half were lost prior to Italy's surrender in September 1943; the rest were seized by Germany.

Type VIIB, VIIC and VIIC/41: The Type VII was classified as a 500-ton vessel, although the types displaced from 745 to 770 tons. All had five 21in torpedo tubes (four forward, one aft), and carried 14 torpedoes, with the Type VII/42 carrying 16. Top speed when surfaced varied between 17 and 17.7 knots with a surface cruising speed of 10 knots. In 1942, Type VII boats were typically equipped with one 88mm deck gun and one light anti-aircraft gun. Later the 88mm was removed to add more anti-aircraft guns. The main difference between the variants was range. The VIIBs, VIICs and VIIC/41 could go 8,500nm. Additionally, the Type VIIC/41 had a stronger pressure hull and lighter machinery. They could dive deeper and were faster than other Type VII boats.

The Type VII was intended for Atlantic operations, the most numerous U-boat used in the Battle of the Atlantic. It was agile when surfaced, and dived quickly. They were particularly useful during the first two years of the war, operating in the eastern Atlantic, relatively close to French bases. Operating in the western Atlantic taxed their limits and they depended on supply boats for extended operations near America.

Between 1936 and 1940, 50 Type VIIBs were built. Type VIIC, the workhorse of the U-boats, started seeing service in 1940 and by war's end 568 had been commissioned. Ninety-one Type VIIC/41 boats were commissioned, with the first entering combat in spring 1944.

Type IX, IXB, IXC, IXC/40 and IXD: The Type IXs were large, oceangoing U-boats, intended for extended operations. There were five variants, with treaty ratings of 750 tons and displacements between 1,050 and 1,616 tons. The Type IXs had six torpedo tubes (four forward, two aft) and carried 22–24 21in torpedoes (ten externally in deck containers). In January 1942 they were armed with a 105mm deck gun and a light anti-aircraft gun, but during 1943 the deck gun was removed and anti-aircraft armament increased. It had a surface cruising speed of 10 knots, and a maximum surface speed of 18.2 knots. The boat was capable of extremely long range, from 10,500nm for the Type IX to 23,700nm for the Type IXD.

A Type XB U-boat. Originally intended for minelaying, the Type XB along with the Type XIV supply U-boat were used to refuel, rearm and reprovision Type VII and Type IX U-boats at sea. (AC)

Eight Type IXs were built, all pre-war, 14 IXBs between 1937 and 1940, 54 IXCs, 87 IXC/40s and 30 IXDs were in commission by war's end. Less popular than the Type VII boats, they took longer to submerge, and were less agile on the surface. However, the most successful patrols of the war were conducted by Type IXB boats.

Type XB and Type XIV: The Type X U-boat was designed as a minelayer. It only had two torpedo tubes aft and could carry 66 mines in shafts designed to release them. At 2,710 tons they were the largest U-boats Germany built, with a top speed of 17 knots and a range of 18,450nm at 10 knots. The Type XIV boat was slightly smaller, with a 2,300-ton maximum displacement. It carried no torpedoes or mines, and was intended as a supply submarine, though it did have anti-aircraft guns. It had a top speed when surfaced of 14.9 knots and a range of 12,350nm at 10 knots.

Both were used as supply vessels, carrying fuel, torpedoes and supplies to allow combat types, especially the short-range Type VIIs, to extend their patrols. However, only the Type XIV was designed for this purpose. The Type X, a pre-war design, had been pressed into a supply role and so called for the design of dedicated supply U-boats.

Eight Type XBs were built; commissioned in late 1941 they entered combat in the spring of 1942. Ten Type XIV boats were commissioned and entered service in March 1942. Six of the eight Type XBs were sunk, as were all ten Type XIVs. Heavy losses led to the cancellation of 14 other Type XIVs.

Type XXI and Type XXIII 'Electroboot', and Type XVII and Type XVIII 'Walter' U-boats: Germany also developed two new classes of U-boats during the war: the 'Electroboot' (Electric boat) and the peroxide-fuelled 'Walter' boats, but they played a negligible role in the Battle of the Atlantic.

The Walter boats used hydrogen peroxide as an oxidiser, allowing it to run diesels underwater. They were streamlined for underwater performance and prototypes reached 23 knots submerged. However, development problems delayed the programme. A combat version was designed, and work started on two U-boats in 1943, but work was stopped in 1944 in favour of the Electroboot.

The Electroboots were designed to primarily operate submerged. Their hulls were optimised for underwater operation, borrowing heavily from the Walter boat, but the Walter's propulsion system was discarded in favour of conventional diesel-electric propulsion. Electroboots had large banks of batteries to facilitate underwater operation, and only needed to surface to periscope depth for combat or to recharge batteries using a Schnorchel for their diesels.

Construction started on the first Electroboot in late 1943. The first were commissioned in summer 1944, but development problems and training delayed operational use until 1945. The first combat patrols took place in Germany's last month in World War II.

Aircraft: The Luftwaffe fielded the FW-200, He-111, He-177, Ju-290 and Ju-88 in the Battle of the Atlantic. It used Ju-88s and He-111 as torpedo and dive bombers to attack Arctic convoys.

By January 1942, the FW-200 Condor was past its best days. Originally a four-engine transatlantic airliner, the FW-200 was hastily converted to a long-range maritime patrol aircraft by attaching a bomb bay beneath the fuselage and adding machine guns and cannon for both anti-shipping and air-to-air defence, but the Condor was structurally weak and virtually helpless against fighters (or even Coastal Command patrol bombers). During the first six months it was used, it faced no opposition, becoming the terror of the Atlantic, but was superseded by the He-177 and Ju-290 four-engine bombers, though even these had limited success. By 1942, few ships were sailing individually and those that did were well armed.

Fighter versions of the Ju-88 began flying sweeps over the Bay of Biscay in 1943 to counter Coastal Command. Originally built as a fast twin-engine bomber, they were modified to long-

range heavy fighters by replacing the bombardier's position with forward-firing guns. These were used extensively in efforts to drive off Coastal Command patrol bombers.

The He-111 and bomber versions of the Ju-88 were used in an anti-shipping role against Arctic convoys. The He-111 was a twin-engine bomber, and served as Germany's main medium bomber throughout most of the war. It first flew in 1935 and was obsolescent by 1943. Equipped with torpedoes or bombs, it served satisfactorily against convoys without air cover.

U-boats were built using traditional methods in conventional shipyards until 1944, which therefore slowed the rate of production and reduced the number of available U-boats in the critical year 1942. (AC)

Facilities and infrastructure

For Germany during the Battle of the Atlantic, geography controlled destiny. Its ability to attack Allied shipping was constrained or facilitated by its available bases.

Geography defined U-boat operations. Type VII U-boats, unrefuelled and unsupplied after leaving port, had an operational range of around 3,000nm. This allowed these boats, Germany's most numerous, to motor 1,500nm after reaching station, a loiter time of six days to two weeks. The larger Type IX boat could reach further: 5,000–6,000nm with a week or two on station for the IXB and IXC boats, and 10,000nm for the long-range IXDs.

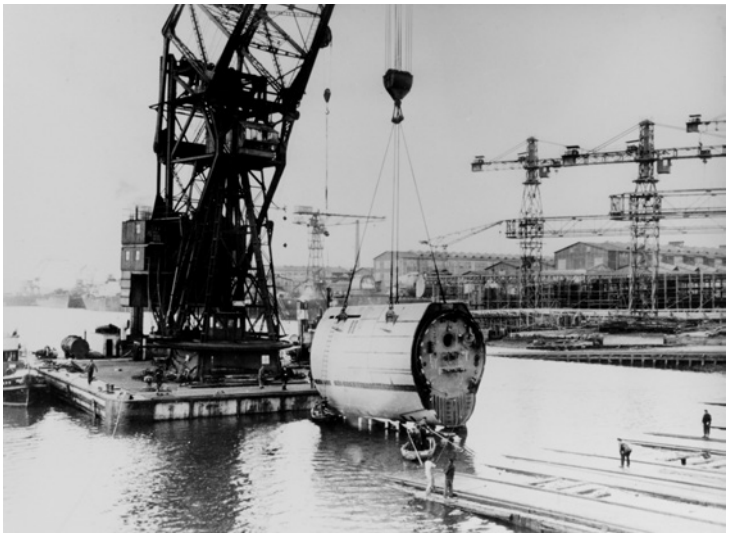
In 1940 and 1941, the battle was fought in the eastern half of the Atlantic Ocean, generally no further west than Iceland. This was two and six days' travel from Norwegian and French U-boat ports respectively, moving at economic speeds. By January 1942 this had become the least fruitful hunting ground for U-boats as anti-submarine coverage was thickest in the eastern Atlantic and most prepared. The American Atlantic coast, the Caribbean, the Gulf of Mexico and South Atlantic, however, were wide open and vulnerable.

But the distances were greater. Operating between Greenland and Newfoundland required a round-trip voyage of 3,000nm. Cape Hatteras, off the Carolina coast, was 3,400nm from Brest and over 3,700nm from Norway. Reaching the oilfields of Trinidad, with its rich harvest of tankers, required travelling over 3,700nm, the Gulf of Mexico nearly 4,700nm and operating off Cape Town required a 5,800nm transit.

Reaching the area between Newfoundland and Greenland was realistic with Type VIIs, and it was possible to operate in wolf packs, especially against eastward-bound convoys. Operating off the US coast was also possible, although loiter time was shorter, and reaching the Caribbean too was possible, but difficult. Unreplenished Type VI U-boats could forget operations in the Gulf of Mexico or southern North Atlantic.

The outer regions, the Caribbean, Gulf of Mexico, and South American and African waters, could be comfortably reached by Type IXs. The first minelaying Type XBs and supply Type XIVs were entering service in the early months of 1942, and these were used to replenish the Type VIIs and extend their range. Furthermore, homeward-bound U-boats with excess fuel or torpedoes could offload their surplus to newly arrived boats, extending their station time.

Geography created another constraint: time. The eastern Atlantic battlefield could be reached in a few days, but as action moved west and south, travel took longer. At 10 knots it took 12–18 days to reach the hunting grounds, assuming the U-boat remained surfaced for most of that time. Frequently, to conserve fuel, they travelled at 5 knots. Forcing U-boats



Germany switched to modular, mass-production of U-boats with the Electroboots, emulating Allied techniques developed in 1940. This allowed 178 Electroboots to be laid down, launched, completed and commissioned between March 1944 and May 1945 – by then too late to matter. (USNHHC)

to submerge increased travel time and shrank range, therefore reducing the number of U-boats attacking the enemy.

When the United States entered the war, Germany had U-boat bases in Germany (Kiel, Hamburg and Wilhelmshaven), Norway (primarily at Bergen and Trondheim) and the Atlantic coast of France (Brest, Lorient, St Nazaire, La Pallice and Bordeaux). These bases contained fortified, reinforced concrete shelters called submarine pens, or sub pens. U-boats also used the Norwegian ports of Horten, Kristiansand, Narvik, Skjomenfjord and Hammerfest, as bases. The last three were in far northern Norway, close to the Arctic convoy routes.

The sub pen building project that began in 1940 was largely complete at the start of 1942. These were massive, reinforced concrete bunkers, several hundred yards wide and long, and protected by concrete roofs as much as 6 yards (5.5m) thick. Similar shelters were also erected at shipyards in Germany that manufactured U-boats. These pens allowed U-boats to remain in port unmolested, and receive necessary repairs and maintenance without risk of damage. They also protected the U-boats' stores and ammunition. Bomber Command ignored these shelters while under construction and vulnerable to attack, instead mounting the first raids in 1942. By then they were impervious to conventional bombs and only the 6-ton Tallboy or 10-ton Grand Slam earthquake bombs could damage them.

Despite numerous air raids on sub pens between 1942 and 1945 no U-boat sheltered in a pen was ever damaged. Bombing could delay manufacture, but only by disrupting supplies before they reached the yards. Once materials were under shelter, they were virtually impossible to destroy.

In January 1942, headquarters for the Führer der Unterseeboote (FdU), was in Lorient, at a chateau called Kerneval. It moved to Paris in March 1942 after the commando raid at St Nazaire left the Germans worried about the security at Lorient. When Dönitz became head of the Kriegsmarine in January 1943, U-boat headquarters moved back to Germany along with Dönitz. Its location was important. Dönitz ran all U-boat operations from this headquarters, though Hamburg and Kiel remained U-boat administrative centres throughout the war.

By January 1942, U-boat production was reaching full capacity. When 1941 ended, Germany had produced 312 U-boats, 199 in 1940 alone, and 1942 would see a further 238 completed, with 286 built in 1943 and 229 in 1944. Most were Type VII and IX boats, but works also started on Type XXI and Type XXIII boats in April 1944.

OPPOSITE TOP
Air-dropped torpedoes, launched from He-111s (shown) and Ju-88s, were used extensively against Arctic convoys. The Germans sometimes used the Golden Comb tactic, in which a line of 20 to 40 He-111s would simultaneously drop torpedoes in the path of a convoy. (AC)

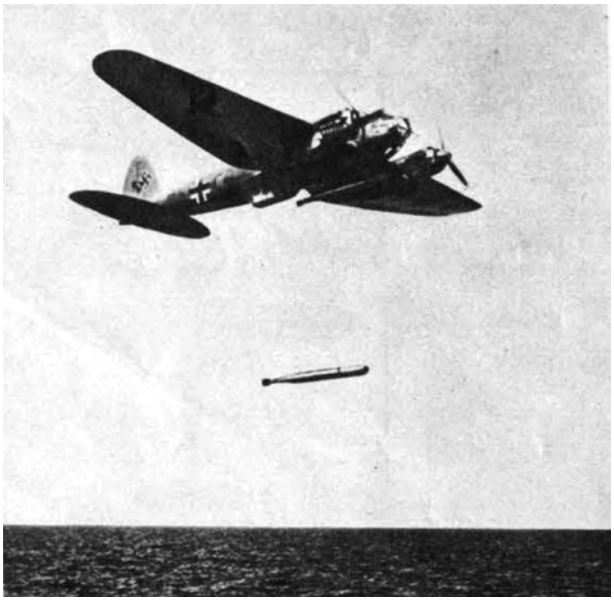
Several hundred more U-boats had been ordered, but not completed. Work on many incomplete Type VI and IX boats was suspended in late 1943 and early 1944 once it was clear these types were obsolete, and work shifted to Electroboots. Others were incomplete when the war ended.

U-boats were built at 19 shipyards during World War II. By 1942, the pre-war U-boat shipyards AG Weser in Bremen, and Deutsche Werke AG and F. Krupp Germaniawerft AG in Kiel, had been joined by 16 new ones, including major yards at Hamburg, Lübeck and Danzig. Blohm & Voss in Hamburg, a major shipyard before World War II, started its first U-boat in November 1939, eventually producing 224. The most important

U-boat construction centres were Hamburg (384 U-boats delivered and commissioned), Kiel (241 U-boats), Bremen (262 U-boats) and Danzig (136 U-boats), accounting for 89 per cent of the U-boats commissioned by the Kriegsmarine.

Despite achieved production, U-boat numbers were never sufficient for Dönitz's needs. Part of this was due to long construction times – working continuously it took eight to ten months between laying the keel of a Type VII U-boat and launching it. Commissioning a U-boat took another three to four months, followed by a six-month training period. On average, it took 18 months between starting work on a U-boat and the time it entered combat.

Long lead times could have been reduced by switching to modular construction, with sub-assemblies built at different locations and sent to the shipyard for assembly. The US had been doing this since 1940 with cargo ships and small escorts.



The loss of K-74

The US Navy used blimps extensively in the Battle of the Atlantic, typically in regions where winter was not a problem: the Eastern Seaboard south of New York, the Gulf of Mexico, the Caribbean, the central Atlantic and the Mediterranean. While blimps were useful for finding and pinning down U-boats until other help arrived, they were not supposed to attack surfaced U-boats. Instead, doctrine called for them to attack only as or after the U-boat dived.

What happened to blimp K-74 of Blimp Squadron ZP-21 on a patrol east of the Florida Straits in the Bahamas shows why this rule existed. Having spotted a U-boat on radar, K-74 made visual contact with U-134 running surfaced, heading in the direction of a nearby tanker and freighter. To protect these ships, K-74's commander, Lieutenant Nelson G. Grills, chose to attack U-134. The encounter ended badly for K-74.

Attacking just before midnight on 18 July 1943, K-74 opened fire with its .50-calibre machine gun at 250 yards. Passing directly overhead, the bombardier dropped two depth charges – which failed to sink the U-boat. A second pass would be necessary.

Meanwhile, U-134's anti-aircraft battery returned K-74's fire, and with a target larger than U-134, successfully hit it. The blimp's starboard engine was knocked out and the cells holding the blimp's helium were repeatedly punctured. Once past U-134, the blimp's bag began deflating, especially aft. The uncontrollable blimp soon settled in the water.

The crew abandoned K-74 after it reached the water. The balloon took a long time to sink. Lieutenant Grills re-entered the gondola to check that all classified material had been tossed overboard. (It had been.) When he exited, he became separated from the others, and decided to swim to shore. Grills was picked up by a SC-657 the next morning, 6 miles from K-74.

Meanwhile, the other eight crew members had stayed together and were spotted the next morning by a Grumman J4F amphibian. While the water was too rough for the amphibian to land, it found the destroyer *Dahlgren*, which rescued seven of the eight remaining crewmen. The eighth was attacked and killed by a shark minutes before *Dahlgren* arrived.

U-134 submerged after the attack, which slightly damaged its ballast tanks. It resurfaced before dawn, its men boarded the still-floating gondola, and photographed artefacts aboard the blimp. It transferred the photographs to another U-boat later in the patrol.

Continuing its patrol, U-134 was badly damaged by a second attack in the Florida Straits, this time by carrier aircraft from USS *Croatan*, and was finally sunk in the Bay of Biscay by HMS *Rother* while running the Bay barrier.

Because Grills sidestepped doctrine to attack a U-boat, some called for his court martial. Others claimed he should receive a commendation for his aggressiveness. He received neither a court martial nor a commendation, instead being transferred to a position where he had responsibility for improving airship tactics.

The two ships Grills was trying to protect from U-134 escaped attack. K-74 was the only blimp lost to enemy action in World War II.

U.S.NAVY

Germany, however, did not adopt this until late 1943, with the Electroboots. By then it was too late to make a difference.

By 1942 the Luftwaffe was supporting the tonnage war, although support was convoluted and uncoordinated. Fliegerführer Atlantik had been established in March 1941 to support the U-boat war. It consisted of Kampfgruppe 40 (KG 40), Küstenfliegergruppen 106, 406, 506, 606 and 906, and Zerstörergeschwader 1. The first was made up of FW-200s, while the rest were a mix of He-111s, He-115s, Do-217s, Ju-88s and Me-110s. (There were both bomber and heavy fighter versions of the Ju-88, and the Me-110 was a heavy fighter.) Later, when they became operational, He-177s, Ju-290s and BV-222s were assigned to these units.

Components of these units operated in French and southern Norwegian airfields, primarily Brest, Bordeaux, Cherbourg and Lannion in France, and Stavanger and Bergen in Norway. KG 40 was headquartered in Mérignac in Bordeaux, although they frequently shuttled to Norway.

Covering maritime activities in Norway was Luftflotte 5 and Fliegerführer Nord. It contained Küstenfliegergruppe 706, and Kampfgeschwaderen 26 and 30. All were armed with a combination of medium bombers (Ju-88s and He-111s) or maritime patrol seaplanes (He-115s and BV-138s). These units attacked Arctic convoys.

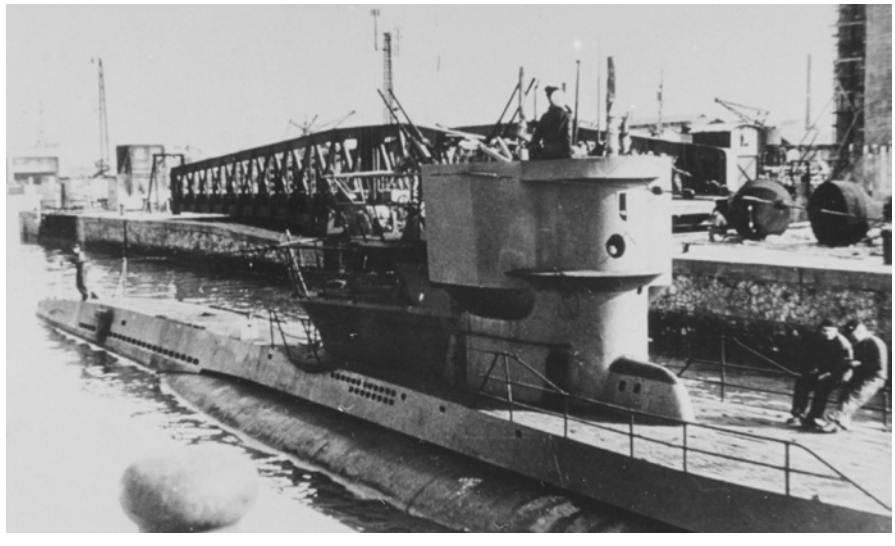
There were never enough aircraft to fully support U-boats, and cooperation with the Kriegsmarine was poor due to inter-service rivalry. Luftwaffe sightings often went unreported to the Kriegsmarine or were delayed long enough to become useless. Additionally, these aircraft often became unavailable as they could be pulled and reassigned to duty in Russia or the Mediterranean.

Weapons and tactics

The U-boat was an offensive weapon fighting defensively against aircraft. Its offensive weapons are as important in understanding what made it vulnerable to aircraft as its defensive capabilities are in defending against aircraft. Additionally, U-boat tactics were a way to overcome its weaknesses.

Torpedoes

The U-boat's main weapon was the 21in torpedo. At the beginning of 1942, the two main torpedoes in service were the G7a T1 compressed air torpedo, and the G7e T2 electrically



In April 1943, in an attempt to counter anti-submarine aircraft, Dönitz began upgrading U-boat anti-aircraft batteries, often removing the deck gun and permitting the mounting of more anti-aircraft guns. He ordered them to stay surfaced and fight aircraft, an order with disastrous results. (USNHHC)

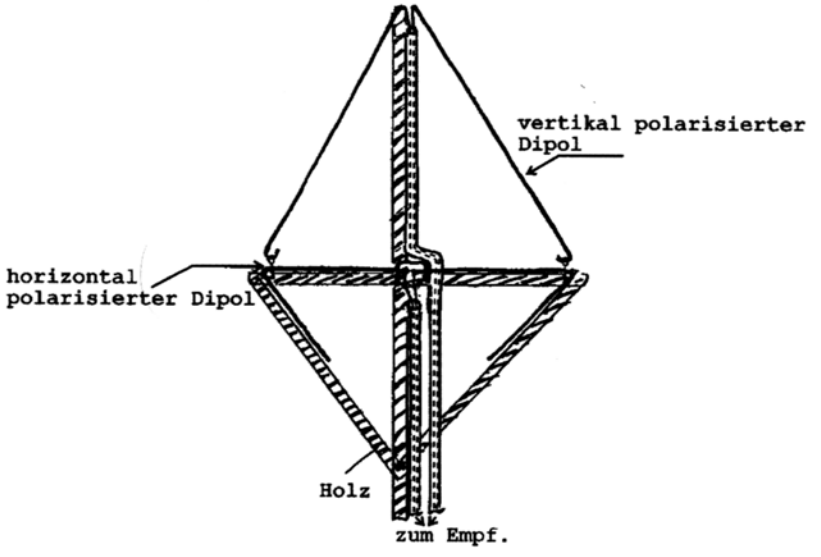


Abb.36: *Biskaya-Kreuz (Zeichnung)*

A Metox antenna as illustrated in a German manual. Metox permitted detection of the metre-wave ASV II radar transmissions. It could not pick up the centimetre-wave ASV Mark III emissions and was withdrawn after a POW falsely informed his German captors that Coastal Command aircraft tracked U-boats using Metox emissions. (AC)

powered torpedo. Both carried a 280kg (617lb) Hexanite-filled warhead – more powerful than TNT, a single hit with a Hexanite warhead could sink most merchant ships. These were fitted with contact triggers, which detonated upon striking a ship. These torpedoes were also fitted with Federapparattorpedo (FAT) gearing during 1942 or Lageunabhängiger (LUT) after mid-1944.

Developed in 1941, the FAT was a series of gears which caused the torpedo to zig-zag back and forth after travelling straight for a pre-set distance. This permitted the torpedo to return to a convoy if it passed through the convoy after missing its initial target. The FAT could also be set to loop left or right, to follow a convoy. While unaimed after the first pass, a good-sized convoy contained enough ships to yield reasonable probabilities of hitting something during return passages. FATs could be fitted to both G7a and G7e torpedoes, although they were available on G7a torpedoes first.

The LUT was an upgraded FAT. It could be fired at any target angle and could follow a curved path to its target. These torpedoes had problems with the steering gear, and frequently become 'tube runners', failing to exit the torpedo tube. They were largely abandoned after December 1944.

The G7a had a range of 8,000m when set for 40 knots or 14,000m at 30 knots. These torpedoes left a visible surface trail of bubbles as they travelled, potentially warning targets of their approach. The G7e could reach 5,000m at their 30-knot setting, if preheated. The G7e left no trail and was simpler to build.

Another torpedo in 1943 was the acoustic torpedo. The Germans called it the *Zaunkönig* (wren) and Allies the German Naval Acoustic Torpedo (GNAT). This torpedo homed in on the target's propeller noise. To prevent it from doing a circle run and hitting the U-boat that launched it, the torpedo followed an initial straight course and had to be fired from a depth of at least 100ft. It had a 24-knot speed and a 6,000m range. Intended for use against escort warships, it was initially highly successful. The British developed countermeasures prior to its September 1943 battlefield introduction, which were deployed soon after.

To have any chance of a hit, a U-boat had to be close to its target – within 3nm. To have a good chance to score a hit, it had to be closer, often much closer.

OPPOSITE SINKING A FLAK TRAP

The Germans outfitted several U-boats with heavy anti-aircraft batteries. These 'flak traps' did not conduct anti-shipping patrols but escorted other U-boats across the Bay of Biscay and attempted to shoot down Allied anti-submarine aircraft. The flak traps worked, as the Germans expected, the first few times aircraft (mostly Coastal Command, but US Army or Navy as well) encountered them. After that, the Allies developed tactics to deal with them.

Anti-aircraft weapons

In addition to torpedoes, U-boats carried deck guns. When the war started, they mounted a light anti-aircraft gun and a bow-mounted 88mm gun on Type VIIs, and a 105mm on Type IX U-boats. The main defence against aircraft was the single 20mm gun mounted on the conning tower. Combat showed the deck gun on the forward deck was unnecessary, rarely useful and potentially a liability. As radar-equipped anti-submarine patrol aircraft numbers increased, the need for anti-aircraft protection likewise increased.

One solution was diving at the first indication that aircraft were present – U-boats became invisible to aircraft once they dived. While ships could track submerged U-boats with sonar, until sonobuoys and MAD were introduced in 1943 aircraft had no means of tracking a submerged U-boat. Even with those, tracking a submerged U-boat was difficult. Diving became less attractive, however, after Fido torpedoes and hunter-killer escort carrier groups appeared. Fido torpedoes tracked a submerged U-boat, and aircraft working with a hunter-killer group vectored sonar-equipped surface escorts to the U-boat's last sighted position.

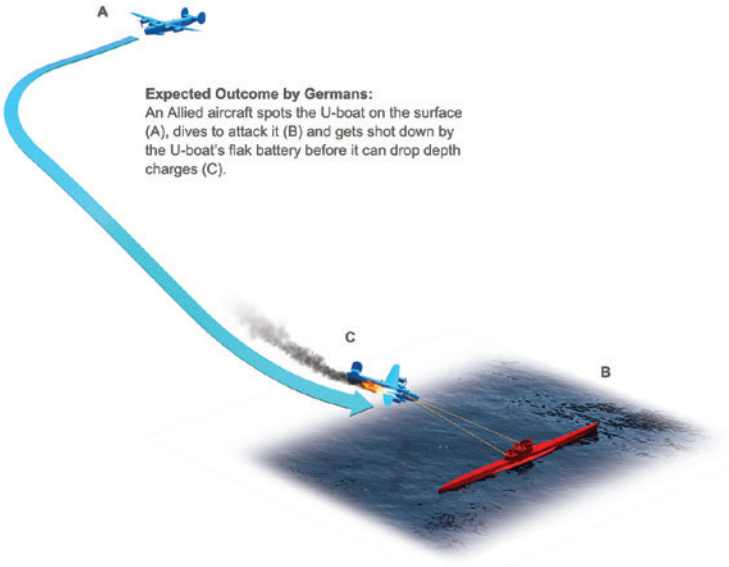
Furthermore, U-boats needed to spend time surfaced. Travelling submerged was slow, and a U-boat could not communicate submerged, having to surface to use its radio. U-boats were expected use radio to report all convoy sightings and report them before attacking the convoy. From his headquarters, Dönitz correlated reports and could then order nearby U-boats towards the convoy.

U-boats could not recharge batteries without running their diesel engines, which required air. Once the Schnorchel was introduced in 1944, a U-boat could operate diesels at periscope depth, but, until then, it needed some way to remain surfaced long enough to recharge its batteries. Once Coastal Command flooded the Bay of Biscay with aircraft it became impossible to cross without a surfaced U-boat encountering some aircraft.

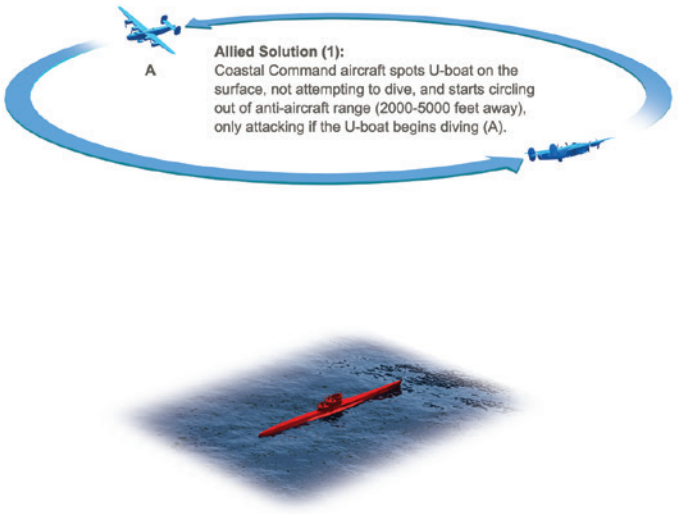
One solution to this was to increase the anti-aircraft or flak batteries. The single 20mm was replaced by a 37mm or a twin 20mm gun. Alternatively, the deck gun was removed and replaced by multiple 20mm or 37mm guns, positioned on a 'bandstand' platform immediately forward or aft of the conning tower. Starting in May 1943, several U-boats were converted to 'flak traps' or flak boats. They had up to four sets of anti-aircraft guns mounted, including quad 20mm and 37mm guns. The torpedo load was reduced by one torpedo in each tube, and the crew size was increased to accommodate the extra gunners. Flak boats were intended to act as surface escorts for U-boats transiting the Bay of Biscay.

Electronic warfare

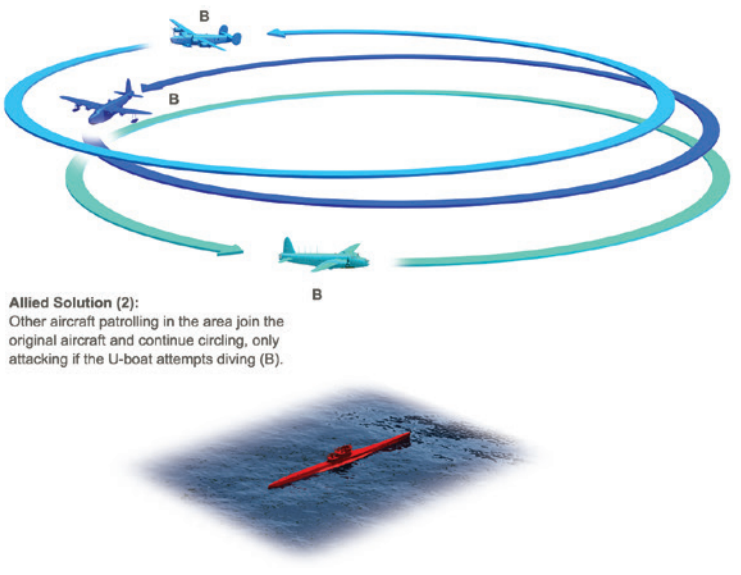
Increasing use of radar by Allied aircraft led to German countermeasures. The first was the Metox radar detector, manufactured by a French company in occupied Paris. An antenna, mounted on a collapsible five-piece wooden frame, picked up emissions broadcast from ASV Mark II radar. The antenna was mounted on the conning tower when the U-boat surfaced and the receiver beeped when it detected radar signals, with the beeping increasing if the U-boat were detected. Since Metox detected aircraft outside typical North Atlantic daytime visual sighting range, it allowed submarines to submerge before aircraft entered attack range. Due to their wooden frame, the Allies dubbed it the Biscay Cross.



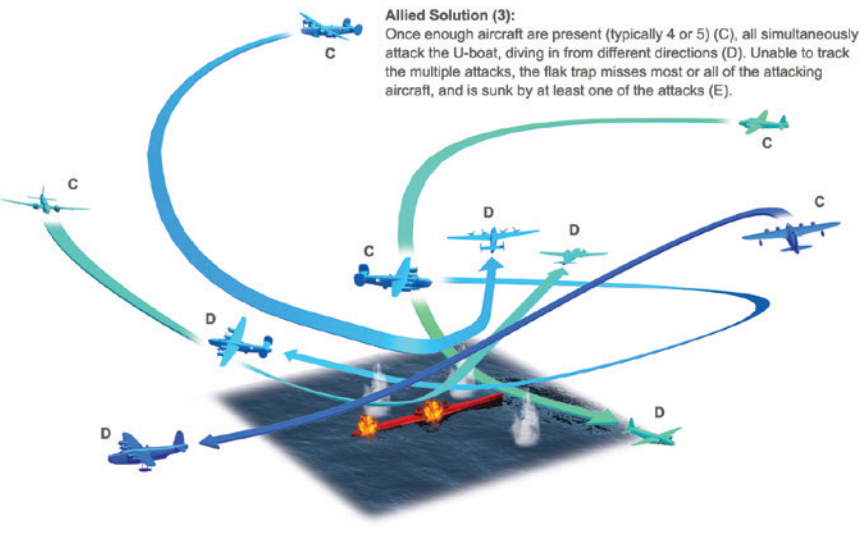
Expected Outcome by Germans:
An Allied aircraft spots the U-boat on the surface (A), dives to attack it (B) and gets shot down by the U-boat's flak battery before it can drop depth charges (C).



Allied Solution (1):
Coastal Command aircraft spots U-boat on the surface, not attempting to dive, and starts circling out of anti-aircraft range (2000-5000 feet away), only attacking if the U-boat begins diving (A).



Allied Solution (2):
Other aircraft patrolling in the area join the original aircraft and continue circling, only attacking if the U-boat attempts diving (B).



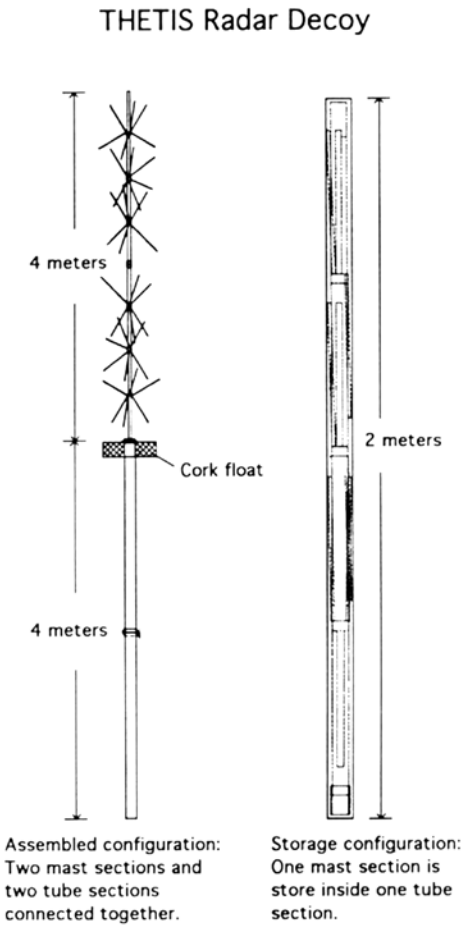
Allied Solution (3):
Once enough aircraft are present (typically 4 or 5) (C), all simultaneously attack the U-boat, diving in from different directions (D). Unable to track the multiple attacks, the flak trap misses most or all of the attacking aircraft, and is sunk by at least one of the attacks (E).

Metox was introduced in August 1942 and proved effective, with Allied patrol aircraft noticing fewer U-boat sightings. Metox's usefulness shrank after April 1943 when the Allies introduced ASV III radars operating on wavelengths Metox could not detect and an upsurge of attacks on surfaced U-boats followed. A captured Coastal Command crewman reported the reason for the upsurge was that Britain was homing in on Metox emissions. (This was technically possible, but the real cause was ASV III radar.) In August 1943, U-boats were instructed to discontinue Metox use, and Metox was retired.

Metox was followed by Naxos, a radar detector capturing centimetre-wave transmissions, allowing detection of ASV III radar. Telefunken of Germany manufactured the detectors. It was developed after an H2S radar set was captured intact when a British bomber crashed over Germany, and was introduced in September 1943. The Luftwaffe took the first sets to help track H2S-equipped British bombers and radar-equipped British intruders. U-boat deployment was further delayed due to fears the Allies could track U-boats from the Naxos emissions, but by December 1943 sets were being installed on the U-boats. By then, the Allies were introducing radars invisible to Naxos.

Aphrodite and Thetis were radar decoys. Aphrodite was introduced in September 1943 and Thetis in February 1944. Aphrodite was a one-metre hydrogen balloon anchored to a raft by a cable with foil strips attached as radar reflectors. An Aphrodite would be released to draw away enemy aircraft tracking a U-boat by radar. Thetis was more sophisticated; a buoy with a radar-reflecting mast, which could float for months. Germany planned to fill the Bay of Biscay with Thetis decoys hoping their reflections would allow U-boats to slip through unmolested. Unfortunately, Thetis proved invisible to many ASV radar. Neither device had an important impact.

The Thetis radar decoy was another attempt to defeat Allied radar. It failed because U-boats could carry only a few, it took a long time to deploy and did not fool experienced ASV radar operators. (USNHHC)


THETIS Radar Decoy
4 meters
Cork float
4 meters
2 meters
Assembled configuration: Two mast sections and two tube sections connected together.
Storage configuration: One mast section is store inside one tube section.

Schnorchel

Invented by the Dutch and installed on their submarines prior to World War II, the Schnorchel (German for snout or nose) was a tube from which a submerged U-boat at periscope depth could draw air and expel exhaust. It was retractable, with a mechanism at the end to block water from entering when the inlet submerged. Initially, Germany ignored the device, removing Schnorchels from captured Dutch submarines but, after massive U-boat losses in spring 1943, the Kriegsmarine revisited Schnorchel as a way to counter anti-submarine aircraft. The Schnorchel was invisible to early versions of ASV radar and could only be picked up by late-war ASVs with difficulty.

Electroboots had Schnorchels as an integral part of the design and Schnorchels were retrofitted to surviving Type IV and Type IX U-boats, starting in 1944. Electroboots had telescopic Schnorchels, while retrofits had Schnorchels on a folding mast. Installation was slow, however, as the war continued the percentage of U-boats with Schnorchels rapidly increased as these boats were more likely to survive.

While largely successful in making U-boats invisible to aircraft, they imposed severe operational limitations on retrofitted U-boats. Even at maximum submerged speeds the boats were slow, and their visual horizon sharply curtailed. They also remained visible to surface escorts equipped with sonar or ASDIC (the British term for sonar).

CAMPAIGN OBJECTIVES

The battle for Europe's lifeline

Convoys were key for both sides in the Battle of the Atlantic. The Nazis had to sink ships before they joined convoys, or find ways to sink them in convoy. The Allies had to form and guard convoys. (AC)

The Battle of the Atlantic began in 1939 with campaign objectives undefined by both sides. No one, except Admiral Karl Dönitz and his U-boat arm personnel, expected the U-boat to play an important role in World War II. But between September 1939 and December 1941, Dönitz proved to the world the threat posed to Britain by the U-boat. Unchecked, it could strangle Britain's war machine by severing its supply lines. By the start of January 1942 both sides had clearly defined objectives for the Battle of the Atlantic. For the Germans and their Axis allies it was interdicting the flow of shipping across the Atlantic with U-boats and aircraft. For the Allies, it was stopping the U-boats and aircraft.

Entry of the United States into the war left these objectives unchanged. Germany could no longer win the war by starving Britain, but losing Britain through a U-boat blockade would make Allied victory more difficult, if not impossible. Both sides had much riding on the U-boat war.

The nature of this conflict meant it was not limited to the North Atlantic Ocean. Dönitz's goal was to sink cargo vessels faster than they could be replaced, regardless of where they were sunk. He sent U-boats wherever a weakly guarded concentration of mercantile tonnage could be found. This took his U-boats to the American Atlantic coast, the Caribbean, the Gulf of Mexico, the North Atlantic between South America and Africa, the South Atlantic and even the Indian Ocean.

The action moved from place to place, depending on where weakness was perceived by Dönitz, who directed his available U-boats to that position. This caused the Allies to reinforce the attacked region, whereupon the U-boats would shift to a new location.

Location mattered less than results. Meeting German objectives required sinking merchant ships in wholesale lots, and that required merchant ships to be present in large concentrations. Meeting Allied objectives meant keeping enough cargo bottoms afloat to supply the Allied war effort in Europe; not just in Britain, but after November 1942 in the Mediterranean as well. That meant keeping cargo ships from being sunk, not just outbuilding losses.

The merchant marine had to grow to support the increasing tonnage required by the growing Allied armed forces in the European theatre. The fastest way to do that was to sink U-boats. It was simply not enough to drive U-boats away from convoys. U-boats had to be sunk in wholesale numbers, and the best way for the Allies to do this was with aircraft. Aircraft could find U-boats faster than warships; they covered more area more quickly than ships could, and their speed and size made it easier for aircraft to surprise U-boats than ships. Even when they failed to sink a U-boat, aircraft could lead warships to the enemy.

For the Allies, achieving their objectives meant employing aircraft effectively. For the Axis, achieving their objectives meant finding ways to nullify aircraft effectiveness. Both tasks were simple to describe, but difficult to achieve.

Allied objectives and plans

The air component of the Battle of the Atlantic remained part of a combined arms battle, including naval, ground and air forces. The overall goal for the Battle of the Atlantic was defensive: maintaining maritime supply lines across the Atlantic. Aircraft by nature were offensive weapons. They could not hold ground, they could only attack or reconnoitre.

January 1942 found the Allies both more and less prepared to neutralise the U-boat threat than at any point in the war to date. The RAF's Coastal Command and the Royal Navy's Fleet Air Arm were more prepared because their air arms were tasked with fighting U-boats, and therefore had been forged into U-boat killing tools. As December ended, Britain was on the brink of taking the Battle of the Atlantic to the U-boats.

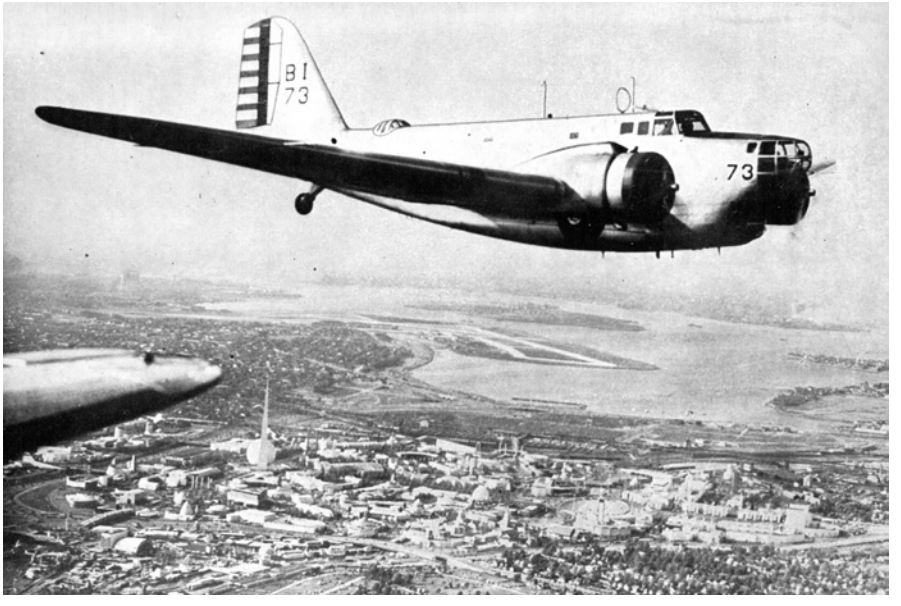
They were less prepared, however, because while Britain had the resources to tame U-boats in the eastern Atlantic, the battlefield suddenly expanded in December, when Germany declared war on the United States. The United States, while a powerful addition to the Allied coalition, was unready for war. It would take six months to develop an effective defence and over a year before the US was fully mobilised with its full potential felt.

As 1942 started, the Allies' main objective in the Battle of the Atlantic was simply to not be beaten. By July 1942, as resources increased the goal shifted from simple survival to a more offensive footing. By 1943, the objective shifted to controlling the sea lanes used by Allied shipping. In 1944 it changed from controlling the sea lanes to actively seeking out and destroying U-boats wherever they were found.

In January 1942 five major organisations were involved in the aerial component of the Battle of the Atlantic: Coastal Command, the Fleet Air Arm, the Royal Canadian Air Force, the United States Army Air Force and the US Navy. The most important of these was then Coastal Command, although over time the USAAF and especially the US Navy played larger roles.

Anti-submarine aircraft required airfields to patrol convoy routes across the North Atlantic. By 1942, Reykjavík airfield in Iceland was one of the most important as it covered the critical North America–Britain route. This shows Reykjavík airfield in 1942. (USAF)

Three were already coordinating closely. The Royal Navy had operational control of Coastal Command. Coastal Command, the FAA and the RCAF were working to a single plan, one beginning to yield results as 1941 ended. The USAAF and US Navy were new on the scene and neither was willing to subordinate its activities to another organisation – either the British or the other American service. The Army Air Force and US Navy had different approaches for using aircraft to



One problem facing the Allies in the western Atlantic in early 1942 was a lack of aircraft capable of being used for anti-submarine duty. Obsolescent aircraft, such as the Douglas Bolo B-18, were pressed into service hunting U-boats. It proved effective in theatres without enemy aircraft. (AC)

attack the U-boat problem and their approaches differed, not only from each other, but from Britain's.

Two years of hard experience had taught Britain that randomly seeking out U-boats in open ocean, whether by surface ships or aircraft, was unproductive. There were too few U-boats and too much ocean. Instead, it assigned most patrol aircraft to convoy support, knowing that U-boats were drawn to convoys. Britain used convoys as bait, but it worked, especially since aircraft could spot and attack U-boats well before the U-boats could attack a convoy. They also learned that patrolling choke points where U-boats had to pass, like the Straits of Gibraltar and the Bay of Biscay, could also be fruitful. While Bay of Biscay patrols found fewer U-boats than convoy support, they had the benefit of forcing the U-boats to operate submerged, thus reducing time on station.

The Army Air Force prided itself on being an offensive service. Its leaders and aircrew viewed convoy support as defensive and boring. It instead favoured offensive sweeps, seeking out U-boats before they neared shipping, whether sailing individually or in convoy. Asserting its independence, the AAF pushed this approach even when its squadrons were assigned to British or US Navy commands.

The US Navy saw its primary role as protecting shipping. It believed the best way to do this was to provide strong escorts, aircraft as well as warships. It believed a convoy with a weak escort against Dönitz's wolf-pack tactics would result in greater losses than allowing ships to sail individually. Thus, it wanted as many aircraft as possible assigned to convoy protection, and viewed patrolling open areas where no convoys were present as a waste of resources. The only exceptions were very narrow passages such as the Straits of Gibraltar or the Florida Straits. It viewed the Bay of Biscay as too large for effective patrolling.

Eventually, methods converged into a common approach, but a final resolution would not occur until August 1943, when the AAF exited anti-submarine warfare (ASW) and the US Navy and British developed operational spheres of influence.

Coastal Command ran the air war against the U-boats almost exclusively prior to US entry into the war, especially after the Royal Navy withdrew its aircraft carriers. The RCAF assumed responsibility for air defence on their Atlantic approaches, but until the US entry, U-boats stayed out of those waters. Eventually, defence became a multinational effort, especially after Brazil and Mexico joined the Allied coalition.

Coastal Command and US forces shared facilities when appropriate. A Coastal Command Sunderland and a USN PBY Catalina are shown at Coastal Command's Pembroke Dock seaplane base during the 1943 Bay of Biscay offensive. (USNHHC)

Matters were further complicated because the head of the US Navy, Admiral Ernest King, mistrusted Britain and was focussed on the Pacific War. He felt, not entirely without justification, that the Royal Navy wanted to subordinate the US Navy in the Atlantic. British control made sense in the Neutrality Patrol era of 1941, when Britain was at war and the US was 'maintaining neutrality' in the Atlantic. Although the US Atlantic naval forces were smaller than those of British Commonwealth nations in early 1942, it would not remain so, and the US Navy became the dominant Atlantic naval power by 1944. While willing to cooperate with the British, King insisted on US primacy in operating the US Navy.

Initially everything ran as before. Coastal Command led the effort; its squadrons operating from the British Isles had four groups. The most important were Fifteen Group and Nineteen Group. Nineteen Group covered the Western Approaches and Bay of Biscay, while Fifteen Group covered the Northwestern Approaches to Liverpool and Glasgow. Sixteen Group covered the English Channel and southern North Sea, while Eighteen Group held responsibility for the northern North Sea and waters around Scotland and Norway. Coastal Command also maintained air headquarters in Iceland, Gibraltar and West Africa.

Each headquarter coordinated airborne anti-submarine efforts in their region, including squadrons outside Coastal Command. This included land-based FAA squadrons and US squadrons in Coastal Command areas. The Royal Canadian Air Force ran anti-submarine efforts off the Canadian coast, cooperating with Coastal Command.

The Army Air Force and the US Navy split responsibility for air defence of the western hemisphere when the US entered World War II. The AAF had not previously envisioned an anti-submarine defence role, but immediately began assigning squadrons belonging to 1st Bomber Command to patrol US coastal waters. Without personnel trained for maritime patrol, however, they initially rotated medium bomber squadrons completing training to anti-submarine duty before sending them to overseas assignment. This worked as badly as expected.

The AAF soon moved to dedicated squadrons using aircraft specialised for anti-submarine warfare. These were either obsolescent types, like the B-18 Bolo, maritime types originally intended for Britain, like the Hudson, and a few four-engine heavy bombers like the B-17 thrown in.

The Army Air Force created the Army Air Force Antisubmarine Command in October 1942 to be the AAF equivalent of Bomber Command. However, in June 1943 the Army decided to let the Navy take over all anti-submarine aircraft. The Army agreed to turn over Army B-24s modified for anti-submarine duty to the Navy in exchange for an equal number of unmodified B-24s that were be to be sent to the Army. Unmodified aircraft on anti-submarine duty were returned to other duties. The handover was completed in August 1943.

The US Navy began the war more prepared than the AAF. The Navy had patrol squadrons in Iceland, Newfoundland, Rhode Island, Norfolk (Virginia), Puerto Rico, the Canal Zone and Natal (Brazil). It also had an airship squadron in Lakehurst, New Jersey. Its aircraft were all twin-engine amphibians. Prior to January 1942 the Navy was only permitted to operate carrier aircraft, flying boats and seaplanes, and lighter-than-air craft.

The Navy rapidly expanded its anti-submarine aircraft, increasing patrol squadron and aircraft numbers. It also was permitted to operate land-based multi-engine aircraft, including the B-24. Between January 1942 and January 1943, the Navy created the US equivalent of Coastal Command. These squadrons cooperated closely with Coastal Command, sometimes embedding in the same bases or hosting Coastal Command squadrons in US bases.

Eventually, Britain and the US divided responsibilities. Britain retained control of anti-submarine activities in the northern parts of the North Atlantic – the convoy routes to Britain from North America. The US assumed responsibility for the central and southern portions of the North Atlantic and the South Atlantic. This included coordinating Brazil's anti-U-boat efforts.

However, separation was not cleanly achieved and US aircraft continued to operate in the British zone, especially from Greenland and Newfoundland. Coastal Command operated out of the Azores in the US sector because the Portuguese would not allow US squadrons until mid-1944. Similarly, the last Army anti-submarine squadron did not stand down until November 1943. Yet all parties cooperated, taking guidance from the nation in charge.

British shipyards launched a million tons of merchant shipping annually, including this just-launched freighter. US shipyards added another 6–12 million tons every year. (AC)

Axis objectives and plans

Karl Dönitz, commander of the U-boat arm of the Kriegsmarine had, in January 1942, one objective: sink Allied shipping faster than it could be replaced. Over time the tonnage available would drop below the minimum needed to supply the British war machine and Britain, unable to supply its armed forces and facing starvation, would then have to capitulate.

He called this concept the tonnage war. It was elegant in its simplicity. It did not matter where the ships were sunk, whether they were carrying cargoes or sailing in ballast. It did not matter what they carried. Sink enough cargo vessels fast enough and victory was assured.

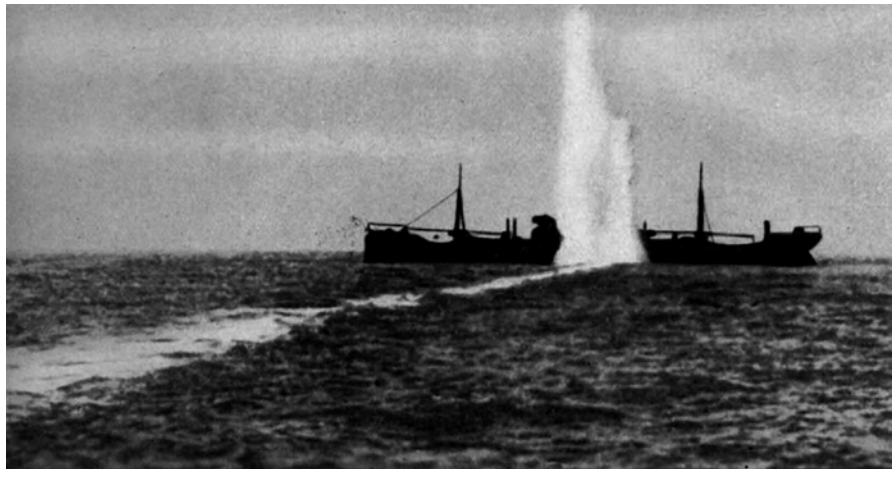
It was a Herculean task. The tonnage war was a game of numbers. When the United States entered the war, Britain and its allies had access to 45 million tons of shipping. By the end of 1945 the US would build another 38 million tons of additional shipping, adding 7 million tons during 1942. British shipyards added another 1.25 million tons of shipping annually, around 100,000 tons per month. Simply keeping up with new US construction required Dönitz's U-boats to sink just under 600,000 tons per month. Reducing the Allied merchant marine required sinking 1 million tons every month. Reducing it significantly required 1.5 million or more tons per month.

Dönitz assumed that with 300 U-boats he could keep 100 at sea at any time. Each U-boat would have to sink at least two ships per month (assuming an average tonnage of 5,000 tons per ship). It sounded achievable to Dönitz.

This meant massing U-boats where they could sink the most ships as quickly as possible, and that was the Atlantic and adjacent bodies, especially the Caribbean and Gulf of Mexico. These waters contained the largest concentration of merchant ships within reach of his forces. To Dönitz, the Baltic Sea, the Black Sea, the Mediterranean, even the Arctic, were sideshows. Their density of shipping was too low.

Dönitz's plan was to flood the Atlantic with U-boats, sending them to operate individually where anti-submarine defences were weak or non-existent, and overwhelming convoy defenders with massive packs of U-boats where anti-submarine defences were strong.

Dönitz started the war with too few U-boats for his tonnage war. However, by 1942 he thought numbers were near what he needed. The total number of oceangoing U-boats in



Dönitz's tonnage war depended on U-boats sinking Allied merchant ships faster than they could be replaced. He underestimated Allied shipbuilding capacities and overestimated the tonnage sunk by his U-boats. (AC)

commission increased from 31 in September 1939 to 182 by January 1942. While only 64 of those were in the Atlantic fighting Dönitz's tonnage war, large numbers of U-boats in the Baltic were completing training.

His numbers would rise. Germany commissioned 16 new U-boats each month in the first half of 1942 and 21 per month in the last half. Nearly 300 more would enter service in 1943. Dönitz reached 100 U-boats on patrol at one time in August 1942. That number would steadily increase until May 1943, when there were nearly 160 boats on patrol.

He would use those numbers carefully. He planned to send large numbers of U-boats on individual patrol in American waters in the winter and early spring of 1942. In January, 20 were to be sent, a third of his available force at that time. More waves would follow. Then he would move to other areas to keep the Allies guessing where his boats would show up next. Additionally, when he had enough U-boats, he planned to attack convoys with 20–30-boat packs. He called this the *Rudeltaktik*, or wolf-pack attack. He believed these numbers would overwhelm the convoys' defenders. His U-boat arm had been honing their skills in pack attacks throughout much of 1941.

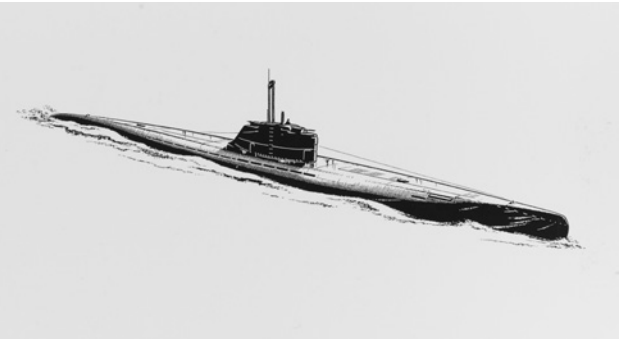
To find convoys he used a combination of intelligence gathering and reconnaissance. In 1942, B-Dienst, the German codebreaking service, broke Naval Cypher No. 3, used by the Allies for communications with Atlantic convoys. Dönitz could read these communications, providing information about the area in which convoys would be found. This was combined with setting up a line of U-boats, spaced 18 miles apart, across the route the convoy would take. Any U-boat spotting the convoy radioed a contact report to headquarters. Headquarters then directed the rest of the pack to the convoy. Destruction followed.

These tactics were devastatingly effective against lightly protected convoys. It was one reason that Admiral King, who worked with the British against U-boats during the Neutrality Patrol, was adamant about providing strong escorts for convoys. Weakly guarded convoys were effective only against individual U-boats.

Yet Dönitz's plans contained serious flaws. The tonnage war required massing U-boats, but Dönitz was often prevented from getting this owing to Hitler's whims. In 1941, 26 U-boats were sent to the Mediterranean. Another nine were sent in early 1942. In January 1942 Hitler ordered 20 U-boats sent to the Arctic to guard against an Allied invasion that was not planned and would never take place. By March, 22 U-boats were patrolling a largely barren Norwegian Sea, half of them U-boats Dönitz intended to send to the American coast. These actions effectively halved the number of U-boats available for the Atlantic.

Another problem was simply finding the convoys soon enough to mass sufficient U-boats to overwhelm the escorts. Coordinating attacks required massive signal traffic to and from

U-boat headquarters, and transmissions could get garbled or lost. The Allies could not read German Enigma messages from February 1942 until that December, but had other means of detecting U-boat locations through their radio transmissions. Combined with other intelligence (including other Enigma traffic) this allowed convoys to be routed around U-boat concentrations. U-boats proved poor reconnaissance platforms, making convoys difficult to find. The result was that most convoys crossed the Atlantic without encountering U-boats.



Dönitz tried to overcome Allied air superiority with a new generation of U-boats called the Electroboot. The Type XXI U-boat (shown in a World War II US Navy intelligence sketch) and Type XXIII U-boat were optimised to operate submerged using Schnorchels. (USNHHC)

The real problem, though, were aircraft. Even in 1942, they made passage through the Bay of Biscay a misery. Additionally, by January 1942, air cover around the British Isles, Iceland, Newfoundland and Gibraltar was strong enough to make wolf-pack operations around those areas inadvisable.

Dönitz felt he had solutions for some problems (although nothing could be done about Hitler's whims). To deal with the issue of finding convoys he sought more cooperation from the Luftwaffe. More aircraft were assigned to long-range patrol. By the end of 1942 he also had enough U-boats at sea that the convoys could no longer evade concentrations. Unfortunately, by then, the convoy escorts were becoming stronger – strong enough to deal with even large wolf packs. These he attempted to counter through the use of new weapons, such as the FAT looping torpedoes and GNAT homing torpedo.

He tried to counter aircraft in two ways. First, he managed to pressure the Luftwaffe into flying cover for U-boats in the Bay of Biscay. Ju-88 heavy fighter squadrons were assigned to fly sweeps over the Bay hunting for the Coastal Command aircraft that were stalking Dönitz's U-boats. He also increased his boats' anti-aircraft batteries so they could fight it out with attacking aircraft. Furthermore, to counter the threat posed by radar, he had radar detectors and radar decoys installed.

When all of these failed, he withdrew his boats from the North Atlantic, seeking areas where aircraft defences were lighter. This was countered by escort carrier task groups sent to harry U-boats in those areas. By June 1943, Dönitz realised his fleet of U-boats was obsolete.

A debate took place among the U-boat officers as to what new objective or plan should be adopted. Opinion was split. Some felt the immense losses with no prospect of success meant the U-boat campaign should be ended, its resources used elsewhere. Others felt that with Germany in peril, the campaign needed to be pressed to its limit, if only to tie down Allied forces.

Dönitz split the difference. A new generation of U-boats was being designed, notably the Electroboot. As a stop gap, until these new U-boats became operational, the current fleet were temporarily withdrawn from attacking the North Atlantic convoy routes. Instead, they were to be used in distant waters, such as the South Atlantic and even the Indian Ocean, with only occasional feints against the Atlantic convoys. This should tie down Allied anti-submarine forces, ships and aircraft that could be used against Germany in more offensive roles if they were not tracking down U-boats. Once the new designs were operational, however, his wolves could return to their North Atlantic hunting grounds and resume the tonnage war.

It would never happen. The Electroboot programme was plagued with developmental delays and teething problems. Material shortages further slowed construction. Training took longer than expected. Even when they finally appeared in the last months of the war, they did not prove the war-winning weapon Dönitz had hoped for. The Allies were already developing countermeasures.

Yet Dönitz had no other course to follow. He had no backup plan, only the tonnage war strategy. He had bet everything on it and, lacking alternatives, had to continue with it or admit defeat.

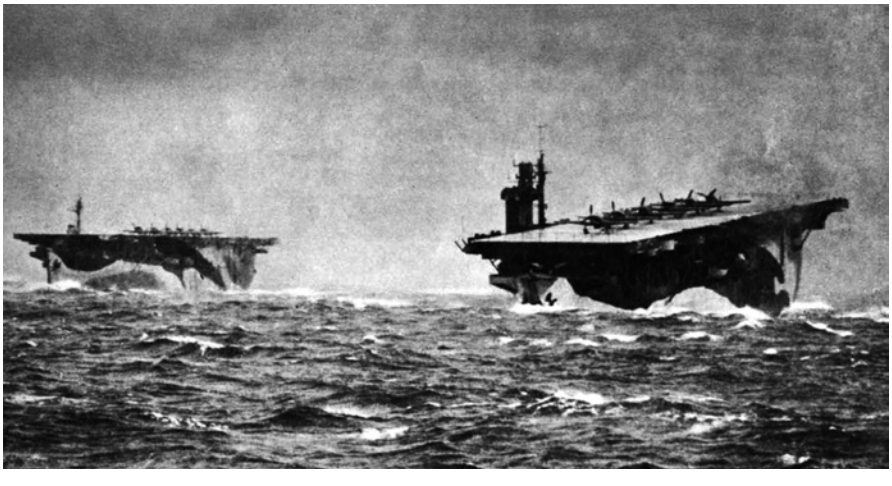
THE CAMPAIGN

The decisive U-boat battles

During the first three months of 1942, the US Navy began escorting coastal convoys with blimps. Although their large size revealed convoy locations, their presence deterred U-boats (then ordered to avoid aircraft) and gave merchant ship crews confidence to sail. (AC)

Before World War II began, few nations, including Great Britain and Germany, believed submarines would make effective commerce raiders. The results of the U-boat war during World War I and improved anti-submarine technology developed during the inter-war years, led Great Britain to assume that the commerce-raiding submarine was a solved problem. Great Britain began World War II ill-prepared for a commerce war conducted by submarines. So did most other naval powers, including Germany, which neglected its U-boat arm until the start of World War II. Among those who believed in the U-boat, Karl Dönitz, commanding the Kriegsmarine U-boat arm and the officers and men within it, soon demonstrated how deadly U-boats could be.

U-boat success was due less to U-boat capability than Britain's unpreparedness. Aircraft, as believed pre-war, nullified the threat posed by U-boats, but only when enough aircraft capable



Two British escort carriers, probably HMS *Archer* (left) and HMS *Charger* (right), encounter heavy weather in the North Atlantic. Escort carriers eliminated Atlantic air gaps by bringing aircraft to where they were most needed to counter U-boats. (AC)

of sinking U-boats were available. In 1939, Britain lacked sufficient numbers of maritime patrol aircraft. Most of the aircraft it had, including its main maritime patrol aircraft, were obsolete. Worse, except for a small number of 450lb depth charges, Britain had no aerial weapons capable of sinking a submerged U-boat, even one a few feet below the surface.

It took two years, but by September 1941, Coastal Command and the Fleet Air Arm had the tools to neutralise the U-boat threat. By December they had scored several important victories – Coastal Command was beginning to sink U-boats. The Royal Navy fielded its first escort carrier on convoys. An epic convoy battle, in December 1941, showed the peril U-boats faced when escort carrier coverage and long-range patrol aircraft combined against a U-boat threat. In a first-ever result, more U-boats were sunk than convoy ships when a wolf pack attacked a convoy.

Then, the war suddenly changed. The United States' entry that December expanded the battlefield dramatically and started a four-year struggle during which Dönitz and his men seemed close to winning, before being subdued and marginalised.

Background: 1935–41

While unlimited submarine warfare almost brought Britain to surrender during World War I, Britain tamed the U-boats in a remarkably short time. After convoys were introduced in May 1917, losses dropped dramatically and largely occurred only in ships sailing individually. Convoyed ships constituted 5 per cent or less of the losses to U-boats, and air patrols further reduced U-boat effectiveness.

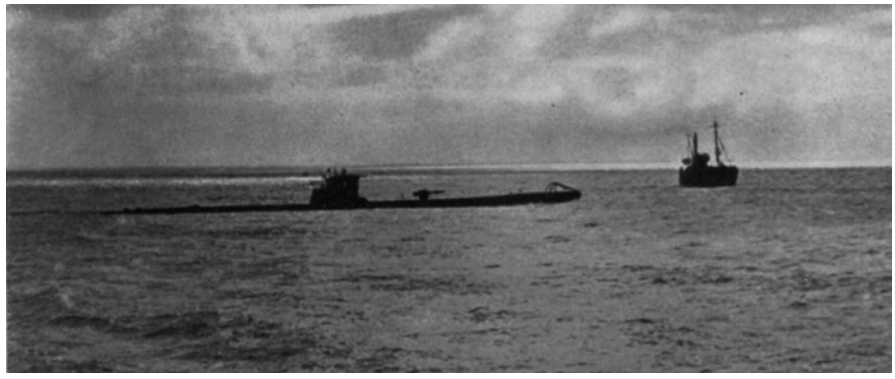
Immediately after World War I ended, Britain developed ASDIC, a means of locating submerged objects through sound waves, and sets were subsequently installed on Royal Navy warships during the inter-war period. The US Navy subsequently developed an underwater sound-based detection system that they called sonar (for SOund Navigation RAnging), the term generally used today. Other navies developed analogous systems.

The combination of convoys, aircraft and ASDIC (or sonar) led most navies by the 1930s to believe a World War I-style anti-shipping campaign was unlikely to succeed. The submarines built in the 1930s were largely fleet submarines, intended to work in coordination with their navy's fleets, and whose primary targets would be other nations' warships. Germany's Kriegsmarine (as it was renamed in 1935) built its new U-boats on that assumption.

One of the few dissenting from that view was Karl Dönitz, named *Führer der Unterseeboote*, commander of Germany's U-boat arm, in 1936. It was a captain's command. Dönitz was promoted to commodore in January 1939, and did not receive promotion to admiral until October 1939. His rise thereafter was meteoric. He achieved the rank of grand admiral (equivalent to the US five-star rank of admiral of the fleet) on 30 January 1943. He was named Hitler's successor in April 1945.

Dönitz believed the 1930s submarine could overcome the disadvantages posed by convoys, sonar and aircraft through appropriate tactics. For example, he realised sonar could not detect surfaced U-boats; they would be lost in the clutter of other ships. A U-boat could attack a convoy surfaced, at night, its low silhouette rendering it invisible. A torpedo attack would ensure the hit ships sank, while providing no telltale muzzle-flashes to betray the U-boat's location. After obtaining hits, the U-boat could submerge, hidden from sonar by the noise of sinking ships.

Karl Dönitz masterminded Germany's campaign to use U-boats against commerce and used its initial success to rise from commodore to grand admiral between 1939 and 1943. He is pictured here (left officer) reviewing a returning U-boat crew, early in the war. (AC)



Dönitz's tonnage war was initially handicapped through following prize rules outlined by the 1930 London Treaty. They required U-boats to surface and check the national status of merchant ships before sinking them. These were abandoned after June 1940. (AC)

To counter the disadvantage of the limited number of torpedoes carried by individual U-boats (limiting the number of ships in a convoy that could be sunk), Dönitz developed the *Rudeltaktik*, a coordinated attack on a convoy by multiple U-boats. This was used to both find and attack convoys. A picket line of U-boats would wait across convoy routes. When a boat spotted the convoy, that boat radioed a contact report, and the rest would converge on the convoy, attacking it at night. After an attack distracted the escorts, additional attacks would follow.

Attacks at night hid U-boats from aircraft as well as ships. In the late 1930s radar was in its infancy. No one imagined that in the space of a few years radar would be miniaturised to fit in aircraft or that large quantities of units could be mass-produced.

Up until World War II, no one other than Dönitz and his men believed this would work, including Dönitz's superiors. Germany had not built the number of U-boats permitted by its treaty with Britain by September 1939. It had 57 U-boats in commission, four fitting out, 16 under construction and 41 on order. The Z-plan, Germany's naval construction blueprint focussed instead on capital ships, including aircraft carriers. At the completion of Z-plan in 1945, Germany would have 249 U-boats, of which 118 were to be completed by 1942.

Of the 57 U-boats available when World War II started, 30 were coastal 250-ton boats with three torpedo tubes (two forward and one aft) and two reloads, that could only safely operate in the North Sea. There were also 18 500-ton boats and nine 750-ton boats.

Despite small numbers and restrictions on their use during 1939 and the first five months of 1940, U-boats racked up a massive toll of Allied shipping. U-boats sank 1.1 million tons of Allied shipping between the start of September 1939 and the end of May 1941.

What made this more remarkable was that this was accomplished despite limited rules of engagement. Initially U-boats were expected to follow the 1930 Submarine Protocol. This meant only troopships, warships and ships in convoy could be sunk without warning. With unarmed merchant ships, the U-boats were expected to surface, stop the ship, determine whether it was a legitimate target and only sink the ship once the crew had abandoned the vessel.

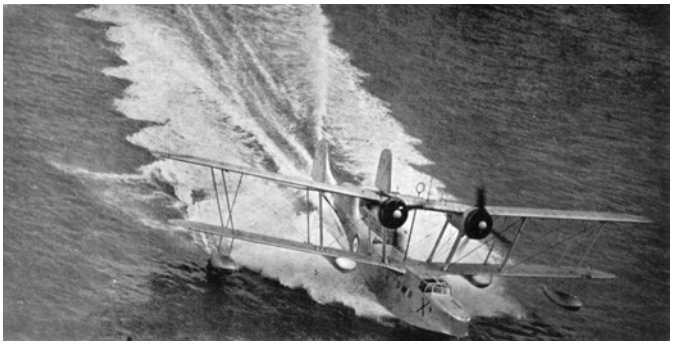
While Germany whittled away at these rules it was not until after the fall of France in June 1940, and Britain's subsequent refusal to make peace, that Germany implemented unlimited submarine warfare. After that, U-boats sank another 2 million tons of shipping.

This was accomplished by a relative handful of U-boats. Except for September 1939 (the month the war started) and April 1940 (the invasion of Norway), there were never more than 24 U-boats at sea on any given day between the start of the war and the end of May 1940. The average was 13 U-boats on patrol. Furthermore, U-boats were plagued with faulty torpedoes during this period, making their success even more remarkable.

It was not that Great Britain lacked effective anti-submarine forces. In fact, 24 German U-boats were sunk between September 1939 and the end of May 1941, over one-third of the

U-boats in commission or placed in commission during that period. The problem lay instead with its anti-submarine aircraft. British aircraft participated in only three sinkings, only one of which was unassisted.

On 14 July 1936 the Royal Air Force reorganised into three operational 'commands': Bomber Command, Fighter Command and Coastal Command. Bomber Command conducted bombing activities and Fighter Command all fighter activities within the RAF. Coastal Command was for maritime air power activities, and this included anti-shipping activities, maritime reconnaissance and convoy protection.



Coastal Command began the war hobbled by obsolescent and inadequate aircraft like this Stranraer, pictured taking off. While soon retired in the European theatre, the RCAF's Eastern Command continued using the biplane flying boat until 1942. (AC)

Despite its vast responsibilities, Coastal Command was the RAF's neglected stepchild. In the late 1930s, a period of limited resources, Bomber Command had first call on resources, Fighter Command came second and Coastal Command had to content itself with whatever was left.

When the war started, what was left was five strike and seaplane aircraft squadrons filled with obsolete biplanes, ten squadrons of inadequate Anson light bombers and four squadrons containing modern aircraft. Three understrength squadrons were equipped with the four-engine Sunderland flying boats. The remaining squadron contained Coastal Command's newest aircraft, the Hudson.

The twin-engine Anson was both short-ranged and could carry only two 100lb bombs, but it remained Coastal Command's main anti-submarine aircraft until the end of 1940. Two new anti-submarine aircraft developed for Coastal Command, the Blackburn Botha and Saro Lerwick (intended to replace the biplane Vildebeest torpedo bomber and the biplane flying boats respectively), proved failures.

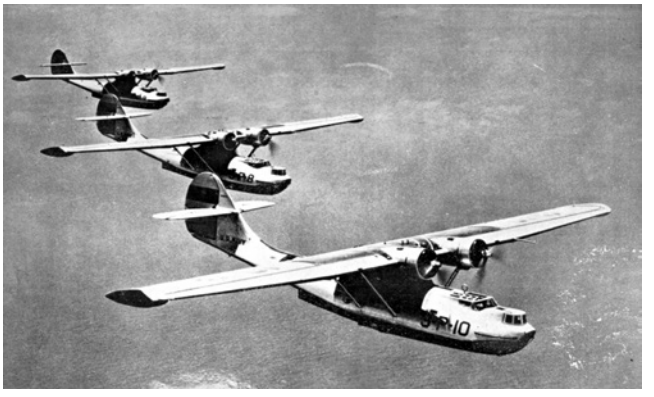
Fortunately, the Hudson was available to replace the Anson, and the Consolidated Catalina could replace the Lerwick. Replacement rates were slow, however, especially for the badly needed Sunderland. Short, Sunderland's manufacturer, was also building the Stirling, Britain's first four-engine bomber. Bomber Command placed a higher priority on Stirlings, so the Sunderland's pre-war slow delivery rate could not be appreciably increased.

Coastal Command was marginally assisted by the Fleet Air Arm during the war's first year. Two fleet carriers, *Ark Royal* and *Courageous* were initially used on anti-submarine duty in the war's opening month, but were hastily withdrawn after one U-boat attacked and missed *Ark Royal* while a second torpedoed and sank *Courageous*.

The only role the FAA played against U-boats until the end of 1940 was during the Norwegian campaign in April 1940. A floatplane Swordfish carried on HMS *Warspite* bombed and sank the Type IXB U-64 while it was anchored at Herjangsfjord northeast of Narvik. The aircraft was not on anti-submarine duties, but rather scouting out German warships.

However, the lack of anti-submarine aircraft for Coastal Command and non-participation by the Fleet Air Arm in the U-boat war was not Britain's biggest problem for its anti-submarine aviation. It was crippled by the lack of effective anti-submarine weapons. In 1939 Britain had only three aerial weapons against U-boats: the 100lb and 250lb anti-submarine bomb and the 450lb air-droppable depth charge.

The 100lb bomb – the only bomb the Anson could carry – was incapable of seriously damaging a U-boat, much less sinking one. Coastal Command only learned this on 10 December 1939, after planting two 100lb bombs on the Royal Navy submarine Snapper. It was a case of mistaken identity. The bombs struck the base of Snapper's conning tower, but damage was confined to shattered crockery and four blown light bulbs.



Coastal Command needed a new seaplane quickly after the failure of the Lerwick, intended to replace biplane flying boats. The Consolidated Catalina, in use by the US Navy since 1937, was available and Britain began acquiring them in 1941. (AC)

The 250lb bomb was a little better. It could crack a U-boat's hull with a direct hit. Contact-fused, it exploded on impact with water. Once a U-boat submerged, however, even a few feet deep, the 250lb bomb could not hurt it. Only the 450lb depth charge could sink a U-boat. Britain was short of them and they could only be carried by Sunderlands. (The only two U-boats credited to Coastal Command from September 1939 to September 1940 were attacked by Sunderlands with 450lb depth charges.)

The solution was an air-droppable 250lb depth charge. Development started early in 1940, but it was January 1941 before the first ones appeared and not until May 1941 that these depth charges were widely available. In July, tactics maximising hit probabilities were adopted and a month later Coastal Command sank its first U-boat using 250lb depth charges. A few days later, Coastal Command aircraft captured U-570.

It broke a long drought. Between July 1940 and August 1941 British aircraft sank no U-boats, even as the U-boat threat grew. New ports on the French Atlantic coast, seized after the fall of France gave U-boats direct access to the British shipping routes. Worse still, a new threat emerged in the form of the Focke-Wulf 200 Condor.

Beginning in September 1940 these aircraft, operating from French or Norwegian airfields, took a terrible toll on merchant shipping. They attacked merchant vessels caught sailing individually, and if they found a convoy they circled it, out of anti-aircraft gun range, radioing its location to German stations. These reports were passed to U-boat headquarters, which vectored U-boats to the convoy. Between September 1940 and February 1941, Condors sank 365,000 tons and U-boats 1.4 million tons of Allied shipping.

The counter to the Condor proved to be ship-borne fighter aircraft: one-shot fighters launched from merchant vessels equipped with catapults or fighters launched from escort carriers. The Royal Navy commissioned its first escort carrier in June 1941. It had a short life, being sunk in December 1941, but during that time provided remarkable anti-submarine and anti-Condor protection for the convoys it escorted.

Coastal Command gained a boost in priority in March 1941, when Churchill issued his 'Battle of the Atlantic Directive', focussing effort against the U-boats and Condors. Coastal Command began getting new and effective aircraft. The first Catalinas entered service in March 1941 and the first Liberator squadron became operational in June. Radar-equipped aircraft began hunting U-boats. In May, Coastal Command started barrier searches in the Bay of Biscay and the Greenland–Iceland–Faeroes–Scotland gap to detect and attack U-boats leaving German ports for the North Atlantic.

Argentia in Little Placentia Harbour, Newfoundland, was obtained through the 1940 Destroyers for Bases swap. Expanded to include an airfield, naval port and seaplane base in 1940 and 1941, it was available for US anti-submarine aircraft when the United States entered World War II. (USNHHC)

Britain also gained a new ally in 1941, a non-belligerent one. Alarmed by German expansion and wishing to contain the Nazis, US President Franklin Roosevelt helped Britain, offering 'all aid short of war'. The United States passed the Lend-Lease Act, allowing Britain to 'borrow' aircraft, ships and weapons until the war's end, and only pay for what was not returned. In April, the United States accepted an invitation by the Danish government-in-exile to protect Greenland, a Danish possession. The United States soon set up airfields and weather stations in

Greenland, both to serve as a potential aircraft ferry route to Europe, and as anti-submarine bases.

In April, Admiral Ernest King, then commanding the US Atlantic Fleet, ordered US naval forces to attack any belligerent European warship or aircraft within 25 miles of western hemisphere land masses. The only exceptions were for nations with colonies in the western hemisphere, therefore Britain, France, Denmark and the Netherlands were exempt from attack, but not Germany or Italy.

The US Army Air Force built airfields in the Caribbean and South America in late 1941, including Atkinson Field, in British Guiana. Intended as an aircraft ferry route from the Americas to Africa, they proved equally useful as bases for anti-submarine aircraft. (USAF)

In May, after the German battleship *Bismarck* broke into the Atlantic, Roosevelt declared an unlimited national emergency. He put the US military on a war footing 'to repel any and all acts or threats of aggression directed towards any part of the Western Hemisphere'. It defined a neutrality zone on the American side of the Atlantic to exclude Germany and Italy, creating an air and naval Neutrality Patrol to enforce that exclusion.

In July, Iceland's government, following US and British arm-twisting 'invited' US protection. The US occupied Iceland with a Marine brigade, allowing Britain to continue Royal Navy and Coastal Command operations in Iceland. In August the US reinforced and later replaced the Marines with US Army soldiers. The Navy transferred two patrol squadrons to Iceland, VP-73 (with Catalinas) and VP-74 (Mariners).

This was part of a general military build-up by the US. In July 1940 the US Congress passed the Two-Ocean Navy Act, vastly expanding the Navy. It implemented the Selective Training and Service Act in September, the US's first peacetime draft and extending it the following year. In June 1941, the Army Air Corps was expanded into the Army Air Force – while still part of the US Army, it was largely autonomous.

One AAF responsibility was hemispheric defence related to aviation. This included anti-submarine defence, although this was shared with US Navy aviation. The AAF had no organisation comparable to Coastal Command, nor was it training personnel for maritime patrol in 1941. Instead, it was developing airfields throughout North and South America. This included expanding the Reykjavík airfield, building or expanding airfields at the bases gained through the Destroyers for Bases agreement, and developing agreements with Brazil for a chain of airfields intended to allow aircraft to ferry to Africa. This yielded an airfield network that could be used for anti-submarine aircraft the following year.

The US Navy was building its own network of patrol squadrons. These were made up of flying boats or amphibians, Catalinas and Mariners, serviced by a seaplane tender, unless shore facilities were available as at Reykjavík and Argentia. At the end of 1941 the Navy had five patrol wings with between two and five squadrons each, and four fleet aircraft carriers and one escort carrier in the Atlantic. However, many patrol squadrons were at half-strength, one of the aircraft carriers (*Hornet*) had just been commissioned and was undergoing its shakedown cruise. A second was the undersized *Ranger*. (As with the Royal Navy, the fleet carriers were considered too valuable to risk chasing submarines.)

The US military build-up was just starting as 1941 ended, and was not scheduled for completion until 1943. When Imperial Japan launched simultaneous attacks against the United States, the Britain Commonwealth nations and the Netherlands on 7/8 December (the date depended on the International Date Line), it changed everything. The war expanded into the Pacific, straining the resources of belligerent Allied nations, and threw the United States into a war with Japan, distracting it from its 1941 focus on Germany. Then, four days after Pearl Harbor was attacked by Japan, Germany and Italy declared war on the United States, further stretching the resources of a nation unexpectedly at war on the other side of the world.

COASTAL COMMAND ORDER OF BATTLE – 1 FEBRUARY 1942		
Group 15 – HQ Liverpool		
Squadron	Base	Aircraft
53	Limvady	Hudson
120	Nutts Corner	Liberator
143	Aldergrove	Blenheim IV
201	Lough Erne	Sunderland
206	Aldergrove	Hudson
210	Oban	Catalina
220	Nutts Corner	Fortress
228	Stranraer	Sunderland
240	Lough Erne	Lough Erne
Group 16 – HQ Chatham		
Squadron	Base	Aircraft
22	Thorney Island	Beaufort
59	North Coates	Hudson
217	Thorney Island	Beaufort
233	Thorney Island	Hudson
248	Bircham Newton	Beaufighter
407 (RCAF)	North Coates	Hudson
415 (RCAF)	Thorney Island	Hampden, Beaufort
500 (RAuxAF)	Bircham Newton	Hudson
502 (RAuxAF)	Bircham Newton	Whitley
Group 18 – HQ Pitreavie Castle, Rosyth		
Squadron	Base	Aircraft
42	Leuchars	Beaufort
48	Wick	Hudson
235	Dyce	Beaufighter
320	Leuchars	Hudson
404 (RCAF)	Thornaby	Blenheim IV
413 (RCAF)	Sumburgh	Catalina
489 (RNZAF)	Sullom Voe	Blenheim IV
608 (RAuxAF)	Leuchars	Hudson
Group 19 – HQ Plymouth		
Squadron	Base	Aircraft
22	St Eval	Beaufort
86	St Eval	Hudson
209	Pembroke Dock	Beaufighter
217	St Eval	Hudson
224	St Eval	Blenheim IV

254	Carew Cheriton	Catalina
502	St Eval	Blenheim IV
10 (RAAF)	Mount Batten	Hudson
1417 (flt)	Chivenor	
AHQ Gibraltar		
Squadron	Base	Aircraft
202	Gibraltar	Sunderland/Catalina
AHQ Iceland		
Squadron	Base	Aircraft
269	Kaldadarnes	Hudson
330 (Nwg)	Reykjavík	Northrop N3P-B
612 (RAuxAF)	Reykjavík	Whitley
VP-73 (USN)	Reykjavík	Catalina
VP-74 (USN)	Reykjavík	Mariner

ROYAL CANADIAN AIR FORCE EASTERN COMMAND ORDER OF BATTLE: 1 FEBRUARY 1942		
HQ Halifax, Nova Scotia		
Squadron	Base	Aircraft
No. 10	Halifax	Digby
No. 11	Dartmouth, NS	Hudson
No. 116	Sheerwater, NS	Canso/Catalina
No. 113	Yarmouth, NS	Hudson
No. 116	Dartmouth, NS	Canso/Catalina
No. 119	Sydney, NS	Hudson
No. 1 Group, St John's, Newfoundland		
Squadron	Base	Aircraft
No. 5	Torbay, NF	Stranraer

UNITED STATES ARMY AIR FORCE ORDER OF BATTLE – 1 FEBRUARY 1942		
I Bomber Command, HQ New York City, and Langley, VA		
43rd Bombardment Group, Godfrey Field, Bangor, ME		
Squadron	Base	Aircraft
13th Bbdmt	Godfrey Field	Havoc
63rd Bbdmt	Godfrey Field	Fortress
64th Bbdmt	Godfrey Field	Bolo, Fortress
65th Bbdmt	Godfrey Field	Fortress
20th Bbdmt	Mitchel Field, NYC	Fortress
34th Bombardment Group, Westover Field, Springfield, MA		
Squadron	Base	Aircraft
4th Bbdmt	Westover Field	Fortress

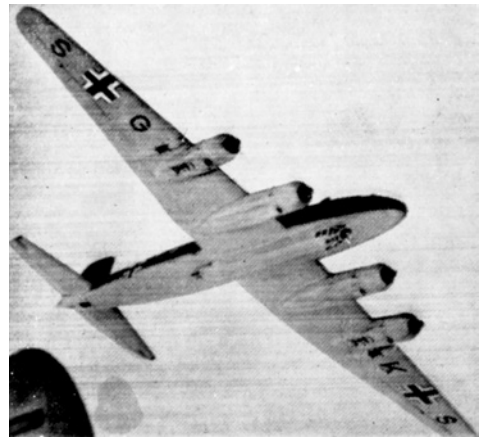
7th Bbdmt	Westover Field	Fortress
18th Bbdmt	Westover Field	Bolo, Fortress
1st Recon	Westover Field	Bolo, Fortress
2nd Bombardment Group, Langley Field, Langley, VA		
Squadron	Base	Aircraft
2nd Bbdmt	Langley Field	Bolo
96th Bbdmt	Langley Field	Fortress
US NAVY ORDER OF BATTLE – 1 FEBRUARY 1942		
Patrol Wing 3		
Squadron	Base	Aircraft
VP-32	NAS Coco Solo, CZ	Catalina
VP-52	NAS Norfolk, VA	Catalina
Patrol Wing 5		
Squadron	Base	Aircraft
VP-31	NAS San Juan, PR	Catalina
VP-81	NAS Key West, FL	Catalina
VP-83	NAS Norfolk, VA	Catalina
Patrol Wing 7		
Squadron	Base	Aircraft
VP-82	Argentia, NF	Hudson
Patrol Wing 9		
Squadron	Base	Aircraft
VP-93	NAS Norfolk, VA	Catalina
Fleet Airship Wing 1, Lakehurst, NJ		
Squadron	Base	Aircraft
ZP-12	Lakehurst	Blimps

The shooting gallery: January–September 1942

Dönitz had a bad month in December 1941. In a battle between a Gibraltar to Liverpool convoy and wolf pack *Seerauber*, more U-boats were sunk than ships in the convoy. Although one of the ships sunk was the escort carrier *Audacity*, only two cargo ships totalling 6,200 tons went down, a poor trade for five U-boats. Less noticed, but more of a bellwether, was the loss of U-451, sunk at night by a radar-equipped aircraft. It was the first loss of a U-boat in this manner, but would be far from the last and foreshadowed the future.

January promised to be better. The spaces patrolled by Britain's Coastal Command and FAA were becoming perilous (witness December's losses), but US entry into the war opened half of the North Atlantic Ocean to German attack. Dönitz believed the North American coast would be a richer hunting ground and safer than the eastern North Atlantic. He planned a big push with his U-boats in American waters and it was to be called Operation *Paukenschlag*.

Although 'Paukenschlag' translates literally as 'drumbeat' or sudden opening beat of the drum, it was also a synonym for thunderbolt, and a thunderbolt was what Dönitz intended



to release. He had 64 U-boats in the Atlantic, and planned to send nearly a third – all 20 Type IX U-boats available.

Reality, however, intervened. Some of the Type IXs were unready for a new mission in late December. Worse, following a commando raid at Vaagsö, Norway in late December 1941, Hitler became convinced that Britain intended to invade northern Norway. Oberkommando der Marine (OKM) sent five Type VII U-boats intended to reinforce Dönitz's Atlantic forces to North Fjord instead, and he was ordered to increase the number of U-boats in the Arctic to 20. Bombers were reassigned from the Atlantic to Norway, to protect against the predicted Allied invasion.

Dönitz committed only ten Type IXs to *Paukenschlag*, six in the first wave, which departed from France in December, and four later. Ten Type VIIs were also assigned to the operation, to cover Canadian waters, the furthest they could reach in winter weather with enough remaining fuel for a profitable patrol. Five ended up becoming the U-boats OKM diverted to Norway, overriding Dönitz and leaving *Paukenschlag* only 15 boats.

The boats were assigned areas along the Atlantic coast from Newfoundland to Cape Hatteras, and given orders to operate individually, to only attack unescorted ships and to use deck guns when possible. To maximise the impact of the assault, they were not to attack before 13 January 1942.

On 12 January, the Atlantic Fleet, on which the blow was to fall, had 150 non-carrier aircraft: 100 Catalinas and 50 other scout and utility aircraft. Only 42 Catalinas were off the

ABOVE LEFT
By 1943 the Allies were deploying new and effective aircraft in significant numbers. These PV-1 Venturas operated from a Caribbean air station in 1944–45. (USNHHC)

ABOVE RIGHT
By 1942 the FW-200 was past its prime. It continued to be used, most notably in the Atlantic in 1944. When armed with stand-off, radio-controlled glide-bombs it attacked Allied warships. (AC)

U-boats largely abandoned deck gun use by late 1940, mainly employing them against still-floating abandoned ships. In American waters from January to March they again began sinking unarmed merchantmen sailing independently with deck guns to conserve torpedoes. (AC)

OPPOSITE STRATEGIC OVERVIEW: FEBRUARY 1942

American coast: eight at Newport, Rhode Island, and 38 at Norfolk, Virginia. Additionally, four blimps operating out of Lakehurst, New Jersey, and 16 Catalinas were split between Argentia and Reykjavík. Admiral Adolphus Andrews, commanding the Eastern Sea Frontier with responsibility for protecting shipping off the US Atlantic coast, had 20 small anti-submarine craft assigned to him. All were short-range and had lighter gun armament than the U-boats they opposed. Andrews could call on the Army for additional aircraft and the Navy for escort warships.

There were no other escort vessels available. What should have been the Navy's reserve was given to Britain in 1940 and 1941. The Navy had to wait for the new construction authorised by the Two-Ocean Navy Act to appear. The few US Navy destroyers available were being used to escort troop convoys or high-priority supply convoys.

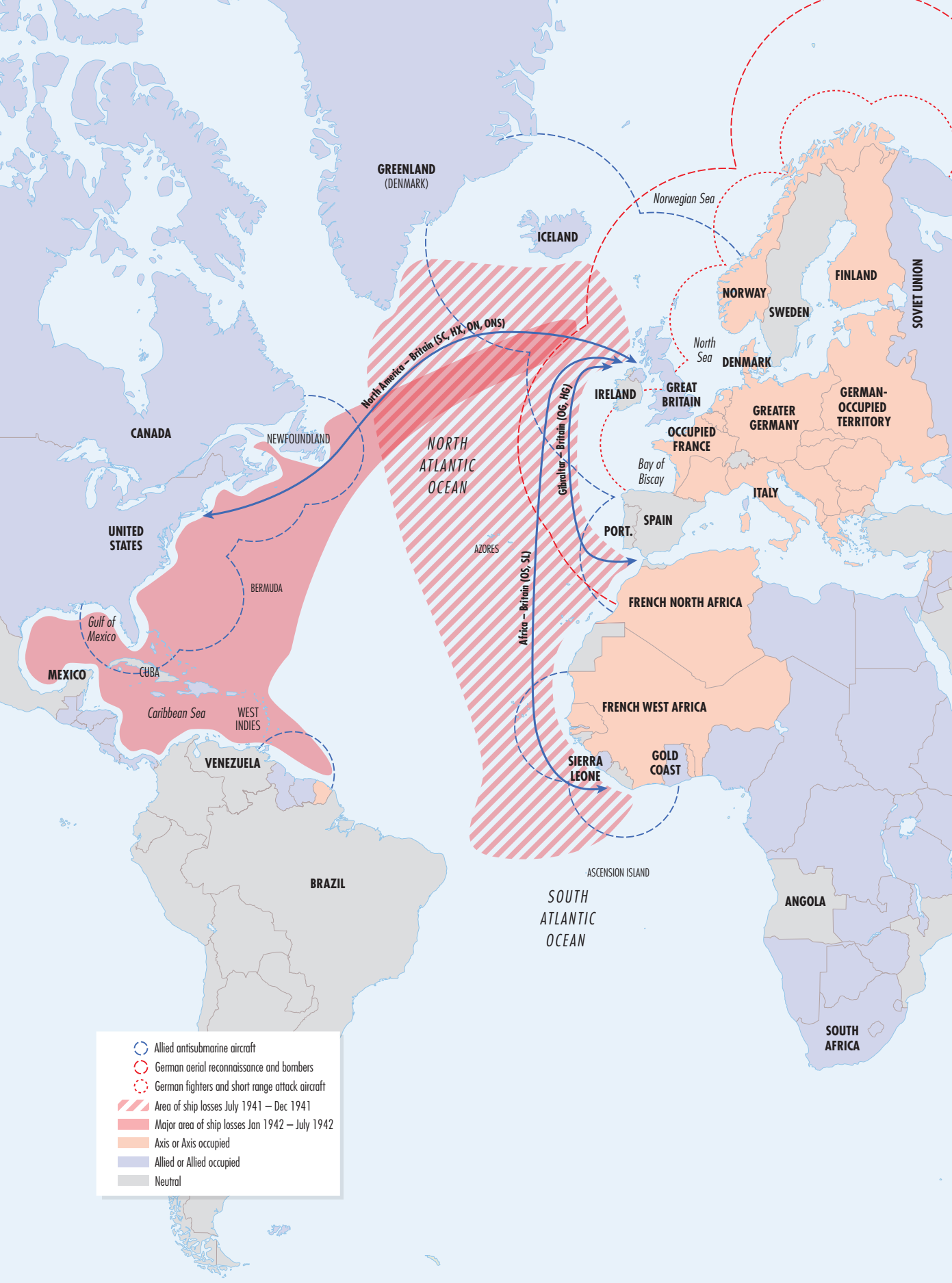
This accorded with US Navy doctrine that a weakly escorted convoy was worse than no convoy, which was true when operating against wolf packs. Even in 1941, wolf packs attacking strongly protected convoys suffered crippling losses while inflicting trivial damage.

Weakly guarded convoys, however, offered protection only when U-boats were operating individually and their movements were uncoordinated. They were effective then because they collected all potential targets into one spot, therefore reducing the chance of detection. Even when an individual U-boat found a convoy, it was likely to sink only a few ships before being driven off by the escorts.

The Navy learned a new lesson in the first four months of 1941: independently patrolling U-boats could sink a lot of unescorted ships. The five *Paukenschlag* U-boats off the US coast sank 23 ships in just a few days. The follow-up waves sank still more. Of the 66 ships sunk by U-boats in January 1942, 39 were sunk in American waters. This was followed by 67 more in February, 66 more in March and 60 more in April.

In January, Dönitz spread his boats throughout the western half of the Atlantic clustered in an arc along the American coastline from the Carolinas to Newfoundland; in February, the arc expanded north of Newfoundland and south into the Caribbean and the oilfields off Trinidad. There it remained through April, with U-boats being sent across the Atlantic as quickly as they could go.

In early 1942 inexperienced US aircrew could not distinguish between a U-boat and a whale, wasting depth charges on whales. The Navy developed training to get aircrew to learn the difference and awarded 'The Royal Order of Whale Bangers' patch to those who persisted in attacking whales. (AC)


GREENLAND
(DENMARK)
ICELAND
Norwegian Sea
FINLAND
NORWAY
SWEDEN
SOVIET UNION
North Sea
DENMARK
North America – Britain (SC, HX, ON, ONS)
IRELAND
GREAT BRITAIN
GREATER GERMANY
GERMAN-OCCUPIED TERRITORY
OCCUPIED FRANCE
Bay of Biscay
ITALY
CANADA
NEWFOUNDLAND
NORTH ATLANTIC OCEAN
Gibraltar – Britain (OG, HG)
SPAIN
PORT.
UNITED STATES
AZORES
Africa – Britain (OS, SL)
FRENCH NORTH AFRICA
BERMUDA
Gulf of Mexico
MEXICO
CUBA
Caribbean Sea
WEST INDIES
FRENCH WEST AFRICA
VENEZUELA
SIERRA LEONE
GOLD COAST
ASCENSION ISLAND
BRAZIL
SOUTH ATLANTIC OCEAN
ANGOLA
SOUTH AFRICA
Allied antisubmarine aircraft
German aerial reconnaissance and bombers
German fighters and short range attack aircraft
Area of ship losses July 1941 – Dec 1941
Major area of ship losses Jan 1942 – July 1942
Axis or Axis occupied
Allied or Allied occupied
Neutral

The US could do little, especially in January and February. There were simply too few aircraft and ships. The Americans had to contain Imperial Japan, then rampaging through the Pacific, and losses of Catalinas and other patrol aircraft at Pearl Harbor and the Philippines had been high, forcing the Navy to send Atlantic patrol squadrons to the area.

Andrews called in AAF aircraft, but found them largely useless. AAF aircraft sometimes caused U-boats to submerge, but they were largely incapable of sinking a U-boat. Their pilots were not trained for over-water patrolling, nor were bombardiers trained to hit moving, evading targets. Most were barely trained, assigned to anti-submarine duty on an ad hoc basis after finishing training but before deploying overseas.

The solution was convoys, but with inadequate escort available the Navy refused to form them. Instead, stopgaps were formed; having ships steam from port to port during daylight hours and anchoring in a port at night, or using unarmed civilian aircraft for anti-submarine patrol. (This eventually developed into the Civil Air Patrol.)

Had the Navy realised that all of the U-boats were operating independently, they might possibly have formed convoys. Against a coordinated multi-submarine attack a weakly guarded convoy become a disaster, as one U-boat found the convoy and multiple U-boats attacked it in turn, each sinking one or two ships and returning to attack again while the distracted escort chased the most current threat. The US Navy saw this play out many times in 1941.

In late January, the U-boat service switched to a four-rotor Enigma machine leading to a codebreaking blackout lasting for most of 1942. The Allies could no longer read U-boat traffic and were unaware of the shift from pack attacks to individual cruises. By the time the US learned of this, the immediate crisis was passing and, by May, enough new aircraft and escort ships were beginning to become available to form convoys on America's east coast.

By then the U-boats had moved on to fresh areas without convoys. In May U-boats were sent to the Gulf of Mexico, where patrols continued throughout the summer. From May to July, just in the Gulf of Mexico, 45 ships were sunk and 13 were damaged. Another 76 ships were sunk in the adjacent Caribbean; over 50 more off the coast of Florida and South America. It was a frightening toll. In all, between January and March U-boats hit 247 ships and another 381 from April to June. Of these, 547 were sunk.

These totals were scored by a very small number of U-boats. The 64 boats available in the Atlantic on 1 January had grown by only 34 (split evenly between Type IV and Type IX boats) by 1 July. Although the daily number of U-boats on patrol in the first six months of 1942 averaged between 60 and 70, that total includes boats in the Arctic and Norway, and also the boats sailing from or returning to port. The number of U-boats actually on the hunting grounds was rarely more than two dozen. Frequently it was closer to a dozen.

Most ships were sunk while sailing independently by submarines on individual patrol. Except in a few places – the Arctic (where no ships sailed except in convoy) and one or two probing attacks against North Atlantic convoys to Britain – Dönitz was not attacking convoys. There were too many easier targets to send his boats against.

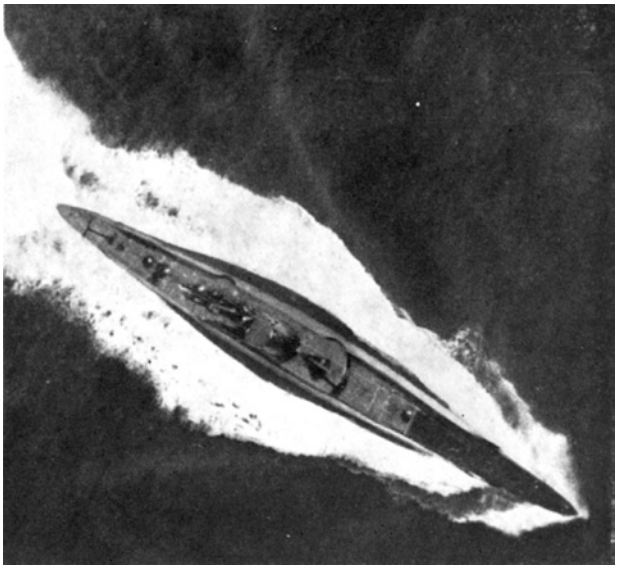
KRIEGSMARINE ORDER OF BATTLE – 1 FEBRUARY 1942
1st Unterseebootsflottille (Brest)
VIIB: U-84, U-86
VIIC: U-201, U-405, U-435, U-558, U-564, U-566, U-582, U-584, U-653, U-654, U-656, U-754, U-1007
2nd Unterseebootsflottille (Lorient)
IX: U-43

IXB: U-103, U-105, U-106, U-107, U-108, U-109, U-123, U-124
IXC: U-66, U-67, U-68, U-125, U-126, U-128, U-129, U-130, U-154, U-156, U-161, U-162, U-502, U-503, U-504, U-505
Ex-Turkish: U-A
Ex-Dutch: UD-3
3rd Unterseebootsflottille (*La Pallice/La Rochelle*)
VIIB: U-85
VIIC: U-82, U-132, U-134, U-332, U-333, U-344, U-352, U-373, U-375, U-378, U-402, U-431, U-432, U-444, U-553, U-568, U-569, U-571, U-701, U-753
6th Unterseebootsflottille (*St Nazaire*)
VIIB: U-87
VIIC: U-136, U-209, U-376, U-404, U-456, U-585, U-586, U-587, U-588, U-589, U-591, U-592
7th Unterseebootsflottille (*St Nazaire*)
VIIB: U-101
VIIC: U-69, U-71, U-94, U-96, U-135, U-403, U-436, U-454, U-455, U-552, U-553, U-575, U-576, U-578, U-581
9th Unterseebootsflottille (*Brest*)
(Formed in October 1941 – no boats assigned as of 1 February 1942.)
10th Unterseebootsflottille (*Lorient*)
IXC: U-155, U-158

LUFTWAFFE ORDER OF BATTLE: 1 FEBRUARY 1942		
KG 40	Bordeaux	FW-200
KG 26	Stavanger	He-111
KG 30	Banak	He-111
KüFlGr-106	Amsterdam-Schipol	Ju-88
KüFlGr-406	Brest, Tromsø and Trondheim	BV-138, He-115
KüFlGr-906	Brest and Tromsø	BV-138, He-115

Individual patrols were also necessary due to the distances travelled. U-boats used so much fuel, reaching places like the Gulf of Mexico, Trinidad or the African coast of the South Atlantic, that they lacked fuel to coordinate with other U-boats. To extend the range of his U-boats, U-boat tankers were deployed. The first two went out in March and April: U-A (built for Turkey, but seized in September 1939) and U-459, the first Type XIV 'milch cow' to see service.

Meanwhile, between January and July, the Allies were chasing U-boats, though usually in vain. They sank 21 U-boats in the first six months of 1942, but only six were sunk west of the Azores. Half of the U-boats sunk were either in the Mediterranean or the Arctic. Coastal Command and the FAA had finally been forged into U-boat killing tools, only to find the waters they patrolled largely empty of prey. Coastal Command and the FAA



Leigh light-equipped Wellingtons scored first blood with Italian submarine Luigi Torelli, like the one shown. It was straddled and badly damaged by an attack on 5 June 1942. In July, U-502 became the first submarine sunk using a Leigh light. (AC)

each sank one U-boat during that period, both in the Mediterranean, but most of the action was outside their areas of responsibility.

US and Canadian forces, though, were capable of sinking U-boats. The US had effective air-droppable depth charges: Hudsons from US Navy Squadron VP-82 operating out of Argentia sank a U-boat with depth charges on 1 March and 15 March; a Mariner from VP-74 sank a U-boat with depth charges west of Bermuda on 30 June. Rather, too few squadrons and too few aircraft were available to cover the ocean in which the U-boats operated. The Navy and Army Air Force were busy building airfields, seaplane bases and blimp bases from which to send patrol squadrons that had yet to exist.

However, matters changed that summer. Squadrons, including blimp squadrons, were finally deployed in the Caribbean and along the Atlantic coast. The AAF began fielding a specialised anti-submarine squadron, equipped with US-built search radar equivalent to ASV III. Some were hand-built prior to mass production of the units, and anti-submarine aircraft got priority for them. Coastal Command began receiving Whitley and Wellington squadrons equipped with ASV III (and Leigh lights for the Wellingtons). These were deployed in the Bay of Biscay.

The result was an abrupt increase in Atlantic U-boats lost to aircraft. From July to September aircraft sank ten U-boats: four in the Bay of Biscay, five off the coasts of the Americas and one in the Iceland–UK gap. Other U-boats were attacked, especially those operating in the Gulf and Caribbean. Losses to U-boats diminished, but only slightly. U-boats sank 311 ships for 1.76 million tons in those months, down from 381 for 2 million tons in the preceding three months. While some losses were incurred within convoys, especially the spectacular losses in Arctic Convoy PQ-17, most were ships still sailing individually.

Regardless, the second 'Happy Time' of the U-boats was drawing to a close. The situation in the Pacific stabilised, and the US began allocating resources to stop Atlantic U-boats. Radar and Leigh lights were becoming more common, and, by September, few ships were sailing unescorted, and the convoy escorts were beginning to match US Navy expectations for adequate escorts. Dönitz would have to start testing his boats against convoys again. Throughout September, the only really ferocious fights against convoys were in the Arctic.

The Arctic convoys were a battle separate yet connected to Dönitz's tonnage war. These convoys carried Lend-Lease supplies to the Soviet Union. The shortest direct route to move supplies from America to the Russian front battlefield went through some of the world's worst weather, from Iceland to either Murmansk or Archangel in Russia. (The Soviet Union could also be supplied through Persia or across the Bering Sea, but those routes took longer.) Convoys had to skirt between the Norwegian coast and the Arctic icepack. During the winter, most of the route was in perpetual darkness; in the summer, especially in June and early July, the sun never set.

The convoys started in August 1941 and sailed monthly thereafter, with a return convoy leaving Russia when the Russia-bound convoy set out. The first dozen convoys, inbound and outbound, took place in 1941 and faced minimal opposition (other than weather). The first convoys sailing in 1942, shrouded by the Arctic night, experienced little opposition either.

Two things changed all that. Following the spring equinox, the daylight periods were longer than the night-time periods, giving German aerial reconnaissance more time to find a convoy. The opportunity to slip through undetected was gone. The theatre had been reinforced due to

Hitler's conviction that an Allied invasion of northern Norway was impending, and there were 20 U-boats and Fliegerführer Nord, containing the equivalent of several bomb groups, guarding the Arctic Circle. Additionally, heavy surface units of the Kriegsmarine (including the battleship *Tirpitz*) threatened intervention.

Starting with the seventh convoy of 1942 (code-named PQ-15) German opposition increased significantly. PQ-15 lost three cargo ships and two warships, although only cargo ships were lost to enemy action. (The warships were accidental casualties.) Eight of 36 merchant ships on PQ-16 were lost, seven to aircraft, one to U-boat and one to a mine.

German efforts against convoys reached a high point with Arctic Convoy PQ-17 in July 1942. It lost 24 of 35 merchant ships to a combination of U-boat and air attack, including the one shown exploding after being torpedoed on 5 July. (USNHHC)

Those losses seemed trivial compared to the next convoy, PQ-17. Of 36 merchant ships in the convoy, 24 were sunk. Only nine reached Russia. Most losses occurred after the convoy was ordered to scatter, a decision taken due to an erroneous belief that the *Tirpitz* planned to attack the convoy. Only three ships were lost prior to scattering. Thereafter 16 were sunk by U-boats or a combination of aircraft and U-boats, and five exclusively by aircraft. None of the nine U-boats attacking the convoy made successful attacks prior to the scatter order. The return convoy QP-13 escaped unscathed due to the Germans concentrating on PQ-17, but lost five of its 35 merchant ships in a 'friendly' minefield off Iceland.

The next convoy to sail, PQ-18 fared better, but not much. Of 40 merchant ships, 13 were lost, despite a massive escort, which included escort carrier *Avenger*. Six merchantmen were torpedoed by U-boats and seven were sunk by aircraft. U-boats accounted for four merchantmen and two escorts on the return convoy (QP-14). A total of 11 U-boats and over 100 Luftwaffe aircraft attacked the convoys. Losses were heavy on both sides, with Germany losing four U-boats and 44 aircraft.

The heavy losses led the Allies to discontinue Arctic convoys until darkness returned.

Crisis point: October 1942–March 1943

As October started, Dönitz finally had U-boats in sufficient numbers to fully exploit his tonnage war strategy. He had kept over 100 U-boats on patrol every day since mid-August, and had enough to make massive attacks against the North Atlantic convoys running from New York to Britain. Now, for the first time in 1942, he was ready to shift his focus to these convoys.

The Allies finally completed a network of convoys to protect shipping in the Gulf of Mexico, the Caribbean, Brazil and up the American coast. An Interlocking Convoy System was established, with two main convoy routes running from Key West in Florida to New York and back again, and from Guantanamo to New York and back. Convoys from the Canal Zone, Curaçao and Trinidad fed the Guantanamo Bay convoys, and convoys from the Gulf Coast (Galveston, New Orleans, Tampa and others) went to and from Key West. Further convoys protected ships from Brazil, linking with the others at Trinidad. Local convoys left at ten-day intervals, express convoys every five days.

Additionally, the terminus of convoys bound to and from Britain shifted from St Johns, Newfoundland, and Halifax, Nova Scotia, to New York City. Ships to Canadian ports now joined or left these convoys at the original termini, when the convoys passed them.

OPPOSITE THE ARCTIC RUN: 1942–1944

The result was that few ships were sailing independently. In October, for the first time since the US entered the war, U-boats sank more ships sailing in a convoy than sailing independently. Half those sailing independently were sunk in the first ten days of that month. The second 'Happy Time' was ending and riskier convoy attacks were necessary.

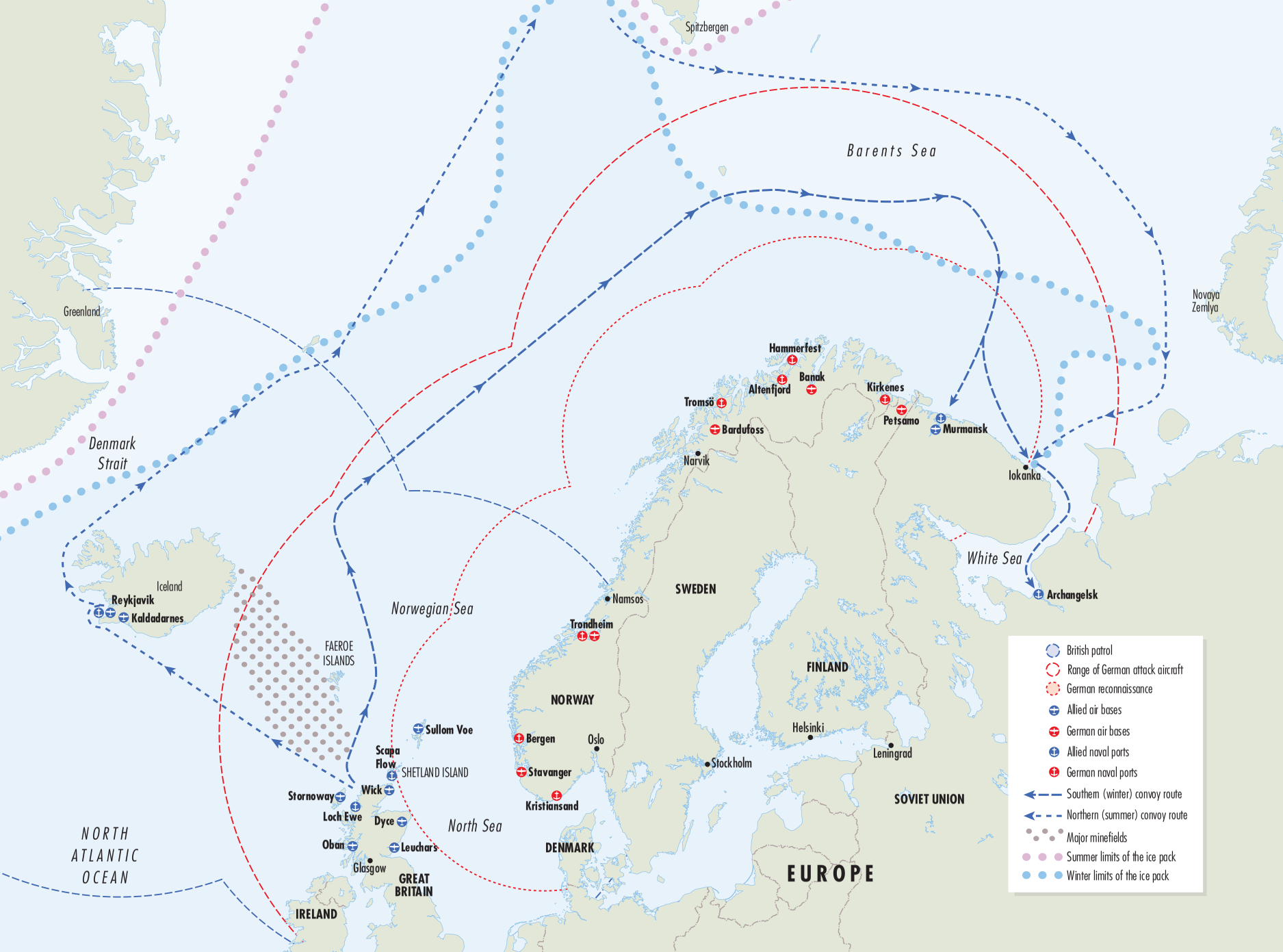
Another reason motivating Dönitz to move against the North Atlantic convoys was the growth of maritime patrol aircraft in American waters. By October, few stretches of the Gulf, Caribbean and American coastal shelf waters were not patrolled by aircraft. In some cases these were not traditional maritime patrol aircraft. For example, the passage to join a New York–Key West convoy from a feeder port took only a few hours, with those ships guarded by short-range single-engine aircraft.

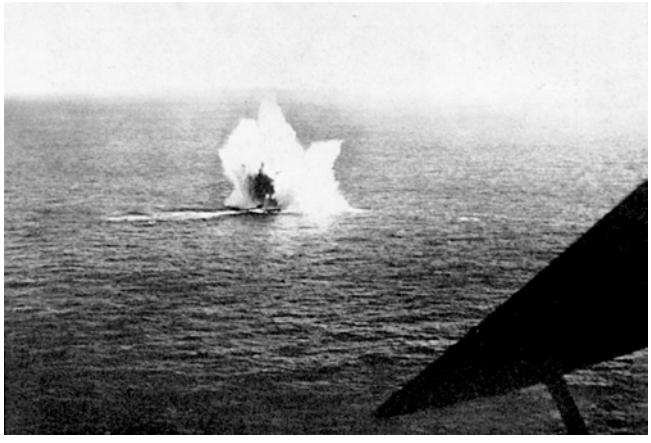
In July, for the first time, half of the U-boats destroyed by the Allies were sunk by aircraft, not warships, and it was no fluke. For the rest of the year, except in December, aircraft sank more U-boats than warships. The number of U-boats lost was up, too. While only 21 U-boats were lost in the first six months of 1942, 66 went down in the last six months – 35 of those in the year's last quarter. This was not yet above U-boat replacement rates and although the U-boat force continued to grow, it grew very slowly in the last three months of the year.

By October around 700 multi-engine aircraft – Bolos (or Digbys in Canadian service), Hudsons, A-20 Havocs, Venturas, Mariners, Catalinas, Sunderlands, Liberators, Fortresses and Halifaxes patrolled the periphery of the North Atlantic (a ring from Gibraltar to the Caribbean). Of these, 300 were long-range or very-long-range aircraft – Catalinas and four-engine aircraft. Blimps patrolled the Gulf, Caribbean and American coastal waters (the American bases were operational, if not complete), and several hundred other aircraft covered the South American coast to Rio de Janeiro and the bulge of Brazil, and across to Africa.

However, there were still air gaps, regions unpatrolled by aircraft, most notably the mid-Atlantic between Newfoundland and Iceland, and the central Atlantic Ocean north of the Azores – these areas were easily reached by Type VII submarines. Other uncovered areas, in the South Atlantic and Indian Oceans, could only be reached by Type IX U-boats,

By October 1942 a chain of coastal convoys was established and the American terminus of transatlantic convoys to Britain shifted from Newfoundland to New York City. This convoy is assembling outside New York harbour prior to departure for Britain. (USNHHC)


Spitzbergen
Barents Sea
Greenland
Novaya Zemlya
Hammerfest
Banak
Altenfjord
Kirkenes
Tromsö
Petsamo
Murmansk
Bardufoss
Narvik
Iokanka
Denmark Strait
White Sea
Iceland
Reykjavik
Kaldadarnes
Norwegian Sea
SWEDEN
Namsos
Archangelsk
Trondheim
FAEROE ISLANDS
FINLAND
NORWAY
Helsinki
Sullom Voe
Bergen
Oslo
Leningrad
Scapa Flow
SHETLAND ISLAND
Stavanger
Stockholm
Wick
Stornoway
Kristiansand
SOVIET UNION
Loch Ewe
Dyce
North Sea
NORTH ATLANTIC OCEAN
Oban
Leuchars
DENMARK
Glasgow
GREAT BRITAIN
EUROPE
IRELAND
British patrol
Range of German attack aircraft
German reconnaissance
Allied air bases
German air bases
Allied naval ports
German naval ports
Southern (winter) convoy route
Northern (summer) convoy route
Major minefields
Summer limits of the ice pack
Winter limits of the ice pack



U-boat losses mounted in the last half of 1942 as aircrew gained experience. The US Navy's 325lb Mark 17 air-droppable depth charge proved deadly in trained hands. (AC)

often only with refuelling. Since only one-third of Dönitz's combat U-boats were Type IXs, a renewed offensive against North Atlantic convoys seemed timely.

The shift began in October, when U-258, a member of the ten U-boat wolf pack 'Wotan', made contact with SC-104, a slow convoy from the Americas to Britain. It had 48 ships and six escorts, and a rescue ship equipped with huff-duff. The boats of pack Wotan began converging on the convoy the next day, 12 October. Over the next four days, boats from Wotan and a second seven-boat wolf pack, 'Leopard', make repeated attacks on the convoy. Eight ships totalling over 35,000 tons were sunk, in exchange for the loss of three U-boats. (One vessel sunk carried ten landing craft, which also went down.) The attack broke off when air cover resumed as the convoy neared Iceland.

Two other major convoy battles took place simultaneously later that month, one against fast convoy HX-212 (from America to Britain) and a second against SL-125, a convoy sailing from Sierra Leone to Britain. Both convoys were attacked between 26 October and 31 October, each over a four-day period.

HX-212's battle started on 26 October, halfway between Newfoundland and Iceland. The convoy was spotted by U-436, part of the 13-boat wolf pack 'Puma', which had just ended a pursuit of an America-bound convoy. HX-212 had 45 ships with an escort of eight warships, a destroyer, a Coast Guard cutter and six corvettes. Over the next four days, nine ships were hit, with six ships of 53,000 tons sunk. Only five U-boats made contact, and three scored hits – U-436 hit five ships with five torpedoes in one attack on the first day. The attack broke off on 29 October, as the convoy reached the patrol range of Liberators stationed in Iceland.

SL-125 was unlucky. The Germans noticed a build-up of Allied activity around Gibraltar (preparations for the November invasion of North Africa), and formed the eight-boat wolf pack 'Streitaxt' to set up a patrol line. However, instead of finding invasion convoys, on 27 October, U-409 discovered the 37-ship SL-125. It had a weak escort, just four corvettes. Over the next four days U-boats torpedoed 19 ships, sinking 12, without loss to the Germans. The attacks ended once the convoy came within range of Coastal Command aircraft west of the Bay of Biscay.

In all three cases the major blow fell in an air gap where the convoy was out of range of patrol aircraft, and the pack attack ended only once the convoy regained air cover. Losses were heaviest in the convoys with the weakest escorts. This set the pattern for the next six months. November would be even worse, the worst month in the war.

The reason for these soaring losses to U-boats was the planned Allied invasion of Northwest Africa, Operation *Torch*. Its convoys sucked up all spare escorts in November. U-boat numbers had also built up to where it was no longer possible to avoid U-boat concentrations. The Enigma blackout continued and the Germans were reading the convoy code. Allied codebreakers could not yet read U-boat message traffic, while German codebreakers passed on ordered course changes sent to convoys. Huff-duff could alert convoys about U-boat concentrations, but there were still too few convoy escorts with the equipment. SC-104 had one, SL-125 had none.

The answer was more aircraft and to fill in gaps with no air coverage. Too few Liberators were being assigned to maritime patrol, and the RAF still gave Bomber Command priority over Coastal Command. It even commandeered Coastal Command aircraft in order to reach the magic number for 1,000-plane air raids over Germany.

Some positive changes had occurred. In October, the AAF formed the Antisubmarine Command, their answer to the RAF's Coastal Command. The AAF had also permitted the Navy to form shore-based anti-submarine patrol squadrons. The AAF first yielded in March, intending it to be temporary but by the autumn had accepted the Navy's role as permanent. Most anti-submarine aircraft were now equipped with radar and Coastal Command even found a way to take advantage of Metox. Coastal Command knew U-boats crossing the Bay of Biscay had orders to dive when they detected radar, so they scheduled air patrols that meant the entire Bay was within range of a radar broadcast, forcing U-boats to cross the Bay submerged or ignore radar warnings.

One reason for high losses on northern Atlantic convoy routes in November 1942 was Operation *Torch*, the invasion of French North Africa. Escorts, surface and aerial, for the *Torch* invasion convoys, like this one off Casablanca, took precedence over North Atlantic convoys. (AC)

Operation *Torch* proved a resource sink for anti-submarine forces, aircraft and ships. US troops involved in the invasion sailed directly from America to Africa in massive troop convoys. In accordance with US Navy doctrine, these convoys received strong escorts, including aircraft carriers. Other convoys therefore went without reinforcement that would otherwise have been available. The *Torch* convoys successfully crossed the Atlantic without losing a ship. While the U-boats did eventually hit 15 ships associated with *Torch*, they did so after the landings, including four large troop transports torpedoed off Casablanca's Fedhala Roads after troops disembarked.

Other convoys fared less well. Trinidad–Aruba–Guantanamo convoy TAG-18 lost six out of 37 ships (including five tankers) for 40,500 tons, to two independently patrolling Type IX U-boats. The 42-ship convoy SC-107 was picked up leaving Newfoundland by a pack of 13 U-boats (with three others joining in). Guarded by a destroyer and four corvettes, the convoy lost 15 ships sunk and had four ships damaged before reaching cover offered by Iceland-based aircraft. In all, 123 ships comprising 769,000 tons were sunk in November for a loss of 13 U-boats.

The invasion of Africa and subsequent operations in the Mediterranean opened a new set of transatlantic convoy routes. Running between New York or Chesapeake Bay and Gibraltar, they were code-named UGF, UGS, GUF and GUS (or US–Gibraltar Fast and Slow, and Gibraltar–US Fast and Slow). These convoys grew as large as the transatlantic convoys between the United States and Britain, and responsibility for them (as well as the network of Mediterranean convoys set up to forward cargoes to Mediterranean ports), fell to the US Navy.

The Allies resumed Arctic convoys in December, renaming the Soviet-bound convoys with the code letters JW and the homeward-bound convoys RA. They departed from Loch Ewe, Scotland, rather than Iceland, and were smaller, with strong escorts. (At times, the escort exceeded the number of merchant ships.) The first sailed on 15 December, slipping through undetected. The second was opposed by four U-boats, Luftflotte 5 aircraft, and a surface force consisting of the pocket battleship *Lützow*, heavy cruiser *Admiral Hipper* and six destroyers.

In the resulting Battle of the Barents Sea, the convoy escorts drove off the Kriegsmarine surface task force. German aircraft and U-boats were equally unsuccessful. Both convoys reached Murmansk without losing a ship, although one ship in the second convoy was damaged. Two more Russia-bound convoys departed in January and February, with three return convoys arriving at Loch Ewe between January and early March 1943. No ships were lost on the Russia-bound convoys, but one was sunk by U-boats on the second return convoy and four of 30 on the third. Thereafter, Arctic convoys were suspended until the return of winter darkness in late 1943.

With the return of Arctic winter, Russian convoys were resumed in December. So were German efforts against them. A He-111 drops a torpedo against Russia-bound merchant ships during the Arctic night. (AC)

The Kriegsmarine's failure at the Battle of the Barents Sea resulted in a shake-up of their leadership. On 3 January, Admiral Raeder, who commanded the Kriegsmarine since its 1935 inception (and had commanded the Reichsmarine from 1928 to 1935) resigned under pressure from Hitler. Dönitz was promoted to grand admiral and given command of the Kriegsmarine, but retained command of the U-boats.

The Battle of the Atlantic slowed in December 1942 and January 1943 due to atrocious winter weather on the northern routes to Britain. Part of it was a simple slow down after the activity of November. Regardless, both U-boat losses and merchant ships sunk by U-boats were down in those months. Twelve U-boats were lost (three to aircraft, four to warships, with the rest lost to accidents) and 107 merchant ships were sunk in those two months. Those totals were lower than the losses of November 1942.

Losses on both sides increased sharply in February 1943, and merchant ship losses surged in March, nearing the total reached in November 1942. A significant fraction of the losses took place in one part of ocean: the North Atlantic between Newfoundland and Iceland. Dönitz concentrated his Type VII U-boats here, out of reach of patrol aircraft.

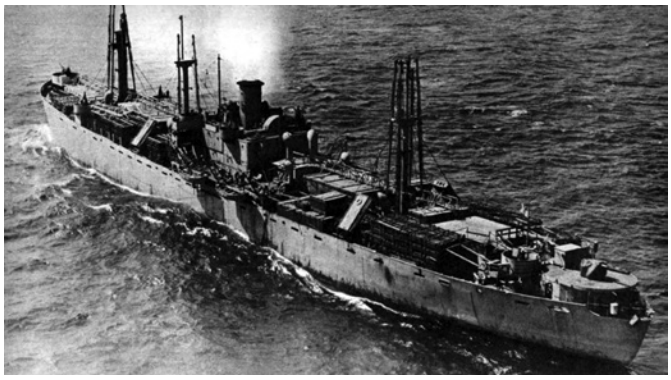
Between 5 February and 20 March, U-boats launched a series of attacks on convoys passing this region. SC-118 with 63 ships had 14 sunk in early February. Two weeks later, ON-166, heading to America with 49 ships, lost 14 more. HX-227 was picked up immediately afterwards, but only lost four sunk. In March, SC-121 lost 14 sunk, HX-228 lost six, SC-122 nine and HX-229 13 ships.

Massive numbers of U-boats were brought against these convoys. Often more than 20 were sent, with eight or nine actually attacking the convoys. Sometimes the U-boats would break off the attack on one convoy as it reached air cover only to start attacks on a convoy entering the air gap going in the other direction.

The U-boats were less successful against the middle Atlantic transatlantic convoys, those bound to and from the United States and the Mediterranean. Part of the reason for this was that these attacks were being made by Type IX boats, less handy than the smaller Type VIIs attacking in the north. The distances involved also meant Type IVs needed U-boat supply ships, and those were limited. The weather was also better, with less dispersion due to storms and fewer stragglers. Smaller numbers played a part, too. While, by March 1943, there were 179 combat boats assigned to the Atlantic, the Germans could not be strong everywhere.

In all, U-boats sank 70 Allied ships for 359,000 tons in February, 108 ships for 585,000 tons in March, and torpedoed and damaged another 41 totalling 382,260 tons during that period. It seemed an unsustainable loss rate. In 1942 Allied shipyards produced 6.5 million

tons of shipping, but had lost 7.8 million tons. Unless the U-boats were checked, the Germans could win the tonnage war. The Germans took heavy losses in February and March, losing 33 U-boats in those months: 13 to aircraft, 14 to warships, two to warships and aircraft, and the rest to accidents. That was well under the German replacement rate, however. Between 1 February and 1 April, U-boats in the Atlantic grew by ten.



By the end of 1942 Allied ship production was soaring. US shipyards were literally launching Liberty Ships, like the pictured *John C. Calhoun*, by the score every week during December 1942, and the rate was increasing. (AC)

Yet German success was more apparent than real. The Allies would produce another 13 million gross tons of shipping in 1943, doubling 1942 production, and the Germans would have to double their sinking rate to keep up. US war production was up and running at full speed by January 1943, with mass-produced warships, including destroyer escorts, beginning to enter service and aircraft production approaching full capacity.

Most of the convoy losses occurred in those escorted primarily by corvettes, which barely matched the speed of surfaced U-boats, and had light gun armament. They were also in areas that could not be reached by aircraft. Other factors would mitigate losses. The Allies were once again reading German U-boat traffic in February, having solved the four-rotor

Fish in a barrel: An RAF Liberator sinks a surfaced U-boat

Although March 1943 marked the month with the highest Allied loss of shipping to U-boats in World War II, unknown to both sides, the course of the Battle of the Atlantic was about to change, and change dramatically, in favour of the Allies.

By the end of March the Allies had enough long-range and very-long-range patrol aircraft to cover the northern transatlantic convoy routes. The Allies installed a new ASV Mark III centimetre-wave radar on their aircraft. ASV Mark III could not be picked up by German Metox radar detectors, which detected the metre-wave transmissions of ASV Mark II radar. Less susceptible to ground clutter than the old Mark II ASV radar, it was less likely to lose a U-boat's echo as it closed.

Combining ASV III with the Leigh light (a steerable aircraft-mounted spotlight) proved deadly to U-boats. An aircraft carrying the new radar could swoop down on a surfaced U-boat at night (especially a moonless night) and snap its Leigh light on to illuminate the U-boat just before the attack. This blinded the deck watch as well as illuminating the target.

These new tools were used by Coastal Command when they opened Operation ***Derange*** on 20 March 1943. ***Derange*** targeted U-boats crossing the Bay of Biscay at night, unaware their Metox detectors no longer warned of impending attacks. Over the spring and summer of 1943, ***Derange*** and subsequent operations soon made the Bay impossible to cross surfaced at night and dangerous even while submerged.

These tools were used to great effect throughout the North Atlantic starting in early 1943, including in the infamous air gap between Newfoundland and Iceland south of Greenland. March saw VLR Liberator squadrons moved to Iceland and Northern Ireland to cover the gap, including RAF No. 86 Squadron, which began operating out of RAF Ballykelly in Northern Ireland at the end of March.

One victim was U-632, a new boat on its second patrol. In the early morning hours of 6 April 1943, the U-boat had just sunk its second victim, the steamship ***Blitar***, its first – and last – kill of its second patrol. Before dawn, nemesis appeared in the form of R-for-Roger, a Liberator Mark V of No. 86 Squadron. A VLR Liberator capable of flying 2,700nm, and carrying both ASV Mark III and a Leigh light, it was patrolling an area the Germans believed beyond the range of Allied aircraft. U-632 was not expecting company.

R-for-Roger picked up a contact on its Mark III radar. Homing in on the contact it spotted a Type VIIC boat heading west – U-632 – and dived to attack.

As it approached, it switched on its Leigh light, bathing the conning tower in light and firing with the two guns in its nose turret. Before U-632's crew could react, the Liberator dropped depth charges on its target, bracketing the U-boat and creating fatal damage. The Liberator observed the U-boat sinking as it pulled away. There were no survivors. It was like shooting fish in a barrel.

system – they never lost it again. They also realised B-Dienst was reading their convoy code and changed it, making it more difficult for U-boats to find convoys. Finally, a number of important technological innovations were coming on line which would render the Type IV and Type IX U-boats obsolete. The tide was turning, and turning quickly.

The tide turns: April–December 1943

The losses so concerned the Allies that an Atlantic Convoy Conference was held in Washington DC to address issues. The conference ran from 1 to 12 March. The British wanted a single anti-submarine warfare command for the entire Atlantic, run out of Western Approaches headquarters in Liverpool. The Canadians wanted an all-Canadian Norwest Atlantic Command, and the return of three Mid Ocean Escort Forces (MOEF) groups lent to support *Torch* in November. The United States, meanwhile, wanted to withdraw from the northern Atlantic convoy routes so they could concentrate their efforts on the mid-Atlantic convoy routes and the Interlocking Convoy System routes in the Americas.

The parties came to the conference wanting complementary solutions. Britain and the United States were willing to let Canada run the Norwest Atlantic Command. The Canadians and British were willing to assume total responsibility for the northern Atlantic convoy routes and let the US take responsibility for the central Atlantic and American convoys. The US was willing to let Britain coordinate Atlantic anti-submarine warfare, if the US could run operations within the US sphere.

Everyone at the conference agreed that more very-long-range Liberators were needed. The problem was wresting more than a fraction of the production away from strategic bombing. Work began to develop more equitable distribution of these aircraft among the three nations and forces responsible for strategic bombing and maritime patrol in the three nations. Anti-submarine escort carriers, beginning to be available, were also allocated between the three partners.

The escort carrier was one of four important technologies introduced that April. The US Navy and the Royal Navy each fielded one in April. It was the first use of anti-submarine aircraft carriers since *Audacity* sank in December 1941. The other three technologies were the centimetre-wave radar, the Fido homing torpedo and anti-submarine rockets. Fido went into production in January 1943, with the US Navy receiving production models in March. Similarly, by March, Coastal Command had finally wrested enough centimetre-wave radar sets to equip its squadrons with the improved radar. Importantly, these could not be detected by the Metox radar detectors.

The escort carrier changed the Battle of the Atlantic. The first escort carriers to protect transatlantic convoys since the sinking of HMS *Audacity* in December 1941 appeared in March 1943. USS *Bogue*, the name ship of its class, began operations on 5 March 1943. (AC)

By the end of March 1943, the anti-submarine aircraft situation had improved significantly and continued improving every month. Off the US Atlantic coast (largely abandoned by U-boats since October 1942), 350 aircraft patrolled. The Navy had one Catalina squadron spread between Rhode Island, North Carolina and Florida, a Mariner squadron at Norfolk, 170 short-range single-engine aircraft (such as Kingfishers or Helldivers) and 18 blimps. The AAF fielded three Bolo squadrons, one B-17 squadron, five long-range B-25 squadrons and four B-34 (the Army's version of the Ventura) squadrons.

Canada had nine RCAF ASW squadrons operating off their Atlantic coast: four with Catalinas or Cansos, four with Hudsons and one with Digbys (the B-18). Several US squadrons also operated out of Canada, mainly out of Argentia. Those squadrons were constantly rotated in and out, as it was where squadrons

were first deployed after finishing training. It allowed them to gain combat experience without facing Nazi aircraft.

In Iceland were two US Navy Catalina squadrons, a Coastal Command VLR Liberator squadron, a Catalina squadron and a Hudson squadron. In Scotland and Northern Ireland, Coastal Command fielded eight squadrons with four-engine aircraft: one VLR Liberator, two Fortress and five Sunderland squadrons. These aircraft patrolled the northwestern, western and southwestern approaches to Britain.

Covering the Bay of Biscay and the Atlantic south to Portugal were a squadron of Liberators, two Halifax squadrons and three Sunderland squadrons, all Coastal Command. There were also three squadrons of Leigh light-equipped Wellingtons. At Gibraltar and Morocco were six more ASW squadrons: two AAF B-24 squadrons, two US Navy and one Coastal Command Catalina squadrons, and a Coastal Command Wellington squadron. Another dozen squadrons of Bolos, Mariners, Venturas and Hudsons patrolled the Caribbean and South American waters.

Better still, from the Allied perspective, 11 other Liberator squadrons were working up: five US Navy, four AAF, one Coastal Command and one Canadian. The Liberator was the most effective anti-submarine aircraft, with the longest range and best bomb load. All 11 would be operational between May and November 1943.

From the Axis perspective, April saw them on the cusp of victory in the Battle of the Atlantic. Dönitz believed he was winning the tonnage war. This was because he uncritically accepted the claims of his captains, while simultaneously undercounting Allied ship production.

It was difficult for a U-boat commander to accurately assess damage done. Most attacks were made at night, with the U-boat seeking to escape immediately after the first torpedoes struck home. It was difficult to determine a ship's size through a periscope or the bridge of a U-boat conning tower, and often a U-boat captain misidentified one ship for a similar-looking larger ship. Or a skipper would mistake which ship was hit, especially once looping FAT torpedoes were introduced. If a FAT missed the 15,000-ton tanker at which it was aimed, it might hit a 2,000-ton general cargo ship when it returned. If a U-boat evaded after firing, its commander might assume it hit the original target. Even honest captains returned with inflated claims.

Similarly, Dönitz considered Allied production figures propaganda. US ship production increased four-fold between 1940 and 1943. Given the difficulties German shipbuilding had experienced in expanding, Dönitz discounted the numbers. There was no way a country could increase ship production that much using traditional shipbuilding techniques. Germany was straining to produce large numbers of much smaller U-boats – the US industrial capacity was utterly inconceivable.

U-boat losses skyrocketed in May 1943. Several factors were involved: arrival of escort carriers, Coastal Command's Bay offensive and increasing numbers of surface escorts and VLR aircraft. Dönitz's 'Fight Back' order contributed, giving aircraft more opportunities to attack U-boats. (AC)

Dönitz also had the largest number of U-boats available in April 1943 that he had ever had. Over 400 were in commission, even if nearly half were still in training or working up. At the end of April, 186 Type VII and IX U-boats were available for combat in the Atlantic, supported by a dozen U-tankers. Production numbers were increasing his fleet by over 20 a month. By autumn he hoped to have 250 boats in the Atlantic.

However, Dönitz worried about Allied aircraft. He still had no counter to them, and there seemed to be more every month, yet they still could not reach the middle of the Atlantic. He was also increasingly worried about radar, both

KEY

- *Orken*
- U-boat
- Path of No. 173 Sqn Wellington
- Path of No. 547 Sqn Wellington
- Path of *Orken*
- Path of U-459

EVENTS

1 1744hrs. A Wellington from No. 173 Squadron makes radar contact with a U-boat, 6 miles to starboard.

2 1750hrs. The Wellington drops out of clouds and visually spots the U-boat (U-459) 5 miles distant. The Wellington attacks U-459, which opens fire on the Wellington.

3 1753hrs. The Wellington crashes into the U-boat's conning tower (possibly because the pilot was killed by anti-aircraft fire), badly damaging U-459 aft when the aircraft's depth charges explode.

4 1800hrs. A No. 547 Squadron Wellington spots U-459 on the surface, circling slowly in a patch of oil.

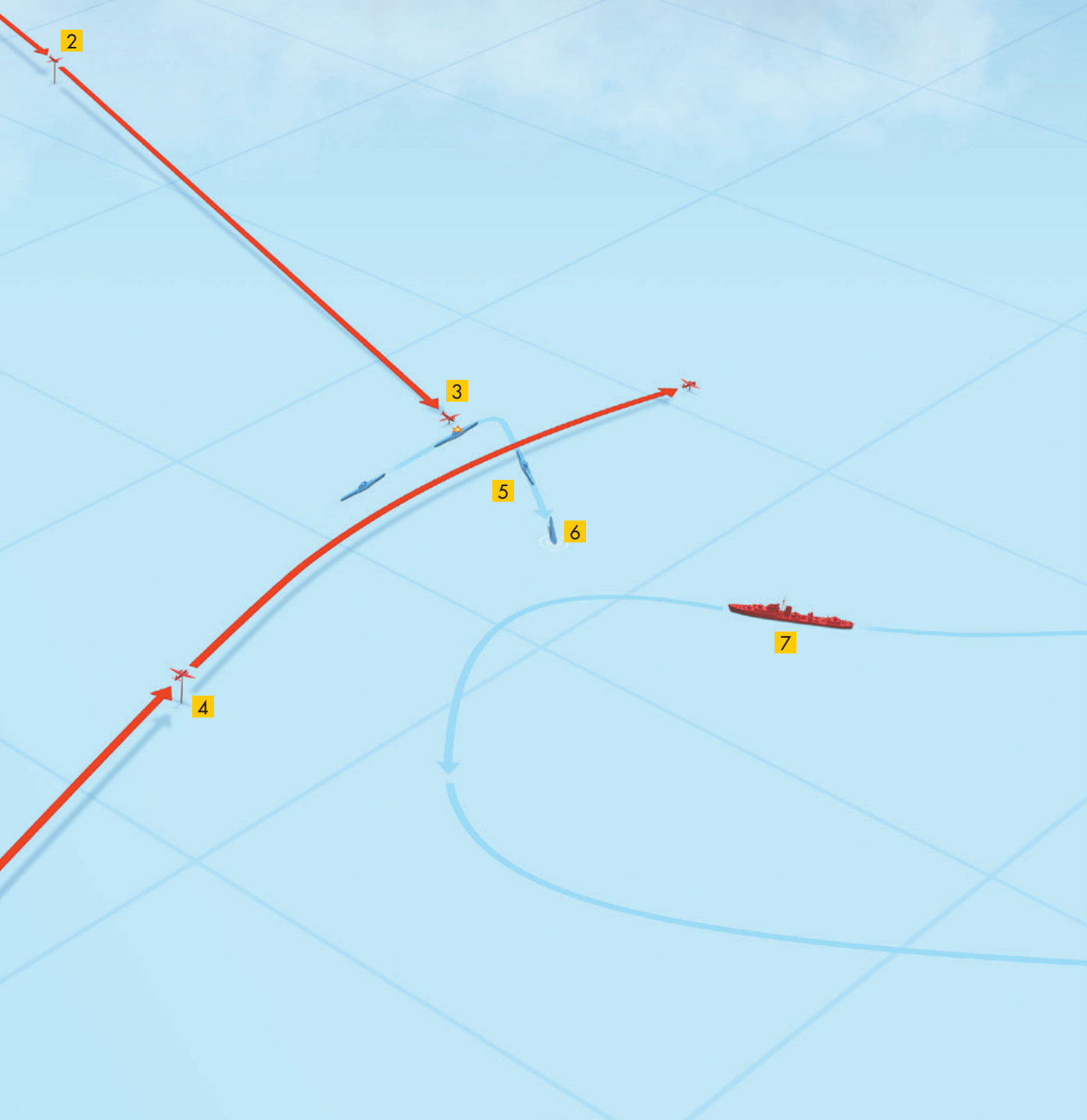
5 1803hrs. The No. 547 Squadron Wellington attacks the U-boat, dropping eight depth charges on it.

6 1815-1900hrs U-459's crew abandons the sinking U-boat.

7 0230hrs. Polish destroyer *Orken* appears searching for survivors. It rescues one British survivor (from No. 173 Squadron Wellington) and 37 surviving Germans.

The Death of U-459

On 23 July 1943 a Wellington enforcing the Bay of Biscay blockade spotted U-459 cruising surfaced from Britain on the aircraft's ASV Mark III radar. It attacked U-459, but was shot down, crashing into the U-boat. The U-boat was damaged by the crash and further critically damaged after unexploded depth charges on the U-boat were rolled over the side and exploded, damaging steering. Unable to dive, it was attacked by a second Wellington 15 minutes later and sunk. Survivors were rescued the next morning by a Polish destroyer participating in the blockade.



OPPOSITE THE DEADLY MONTH: MAY 1943

ship and airborne. By late winter 1943 he began fielding countermeasures, radar detectors and radar decoys.

In February and March many Allied aircraft were fitted with ASV III radar, undetectable by Metox receivers. Sir John Slessor, who took over command of Coastal Command in February 1943 started a new Bay of Biscay offensive on 20 March. Slessor described the Bay as the trunk of the U-boat's tree. Chop off the trunk and the rest would fall. Aircraft equipped with Leigh lights and centimetre radar, began attacking U-boats crossing the Bay.

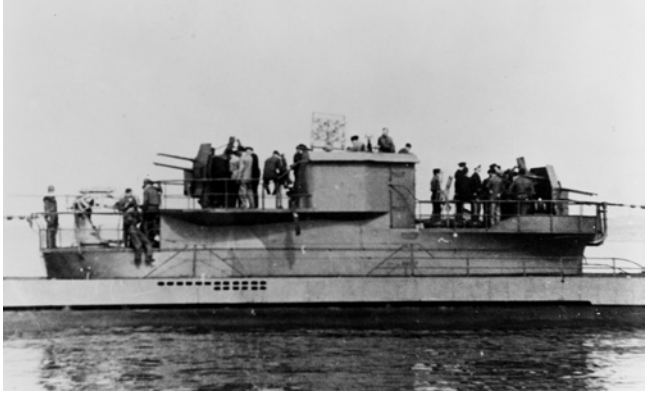
Coastal Command sank only one U-boat in the Bay both in March and in April, largely because they were still perfecting tactics. Regardless, many U-boats found it necessary to dive suddenly, when, with no warning, the deck watch were caught in a Leigh light from an attacking Coastal Command aircraft. Several U-boats were damaged and returned to port. Others successfully dived without receiving serious damage. By mid-April Dönitz had ordered U-boats to cross the Bay of Biscay submerged at night and to surface during daylight hours, staying surfaced only long enough to recharge batteries.

Despite the slow start to Coastal Command's Bay offensive, April was a good month for the Allies. Convoy escorts, both warships and aircraft, sank another 16 U-boats in April, while losing only 49 ships to U-boats. Different factors caused the change, of which several were operational. Convoy sizes were increased with the number of convoys sailing reduced due to Operations Research studies. (They indicated that losses would drop if fewer, but larger convoys were used.) This reduced the opportunity for U-boats to find convoys, while allowing bigger convoy escorts.

Convoy HX-231 to Britain was the cause of the fiercest battle of April. With 67 ships and 19 escorts it was attacked by 11 U-boats, most of which came from the 'Lowenherz' wolf pack. Six merchant ships were sunk, most in the air cover gap, but two attacking U-boats were also sunk, and five others were damaged seriously enough to require repairs in port.

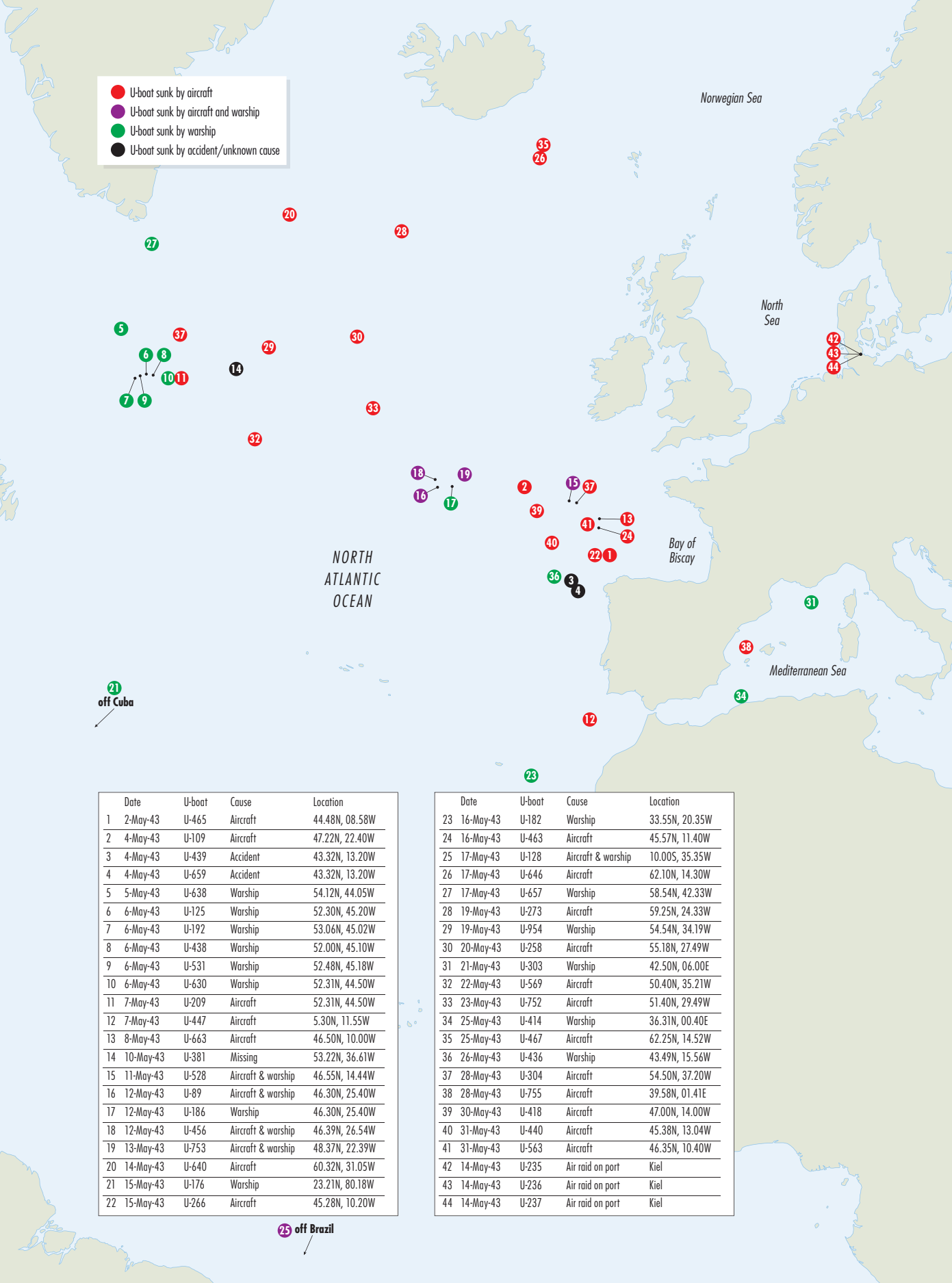
May was another story; an unmitigated disaster for the U-boats. A total of 41 U-boats were lost at sea. (Three more were bombed and sunk in the shipyard while being built, but those were refloated, repaired and completed.) Aircraft sank 24, four in cooperation with warships. U-boat losses exceeded production and were so bad that, on 24 May, Dönitz ordered his U-boats withdrawn from the North Atlantic.

There were several causes for the spike in losses: days were getting longer, stripping U-boats of the cover of darkness; more VLR Liberators were available, shrinking the gap between Newfoundland and Iceland; spring weather permitted Catalinas to operate from Greenland, further reducing that air gap; and new weapons such as rockets and Fido contributed. The most important two reasons, however, were a change in U-boat policy towards aircraft and the appearance of escort carriers in the North Atlantic.



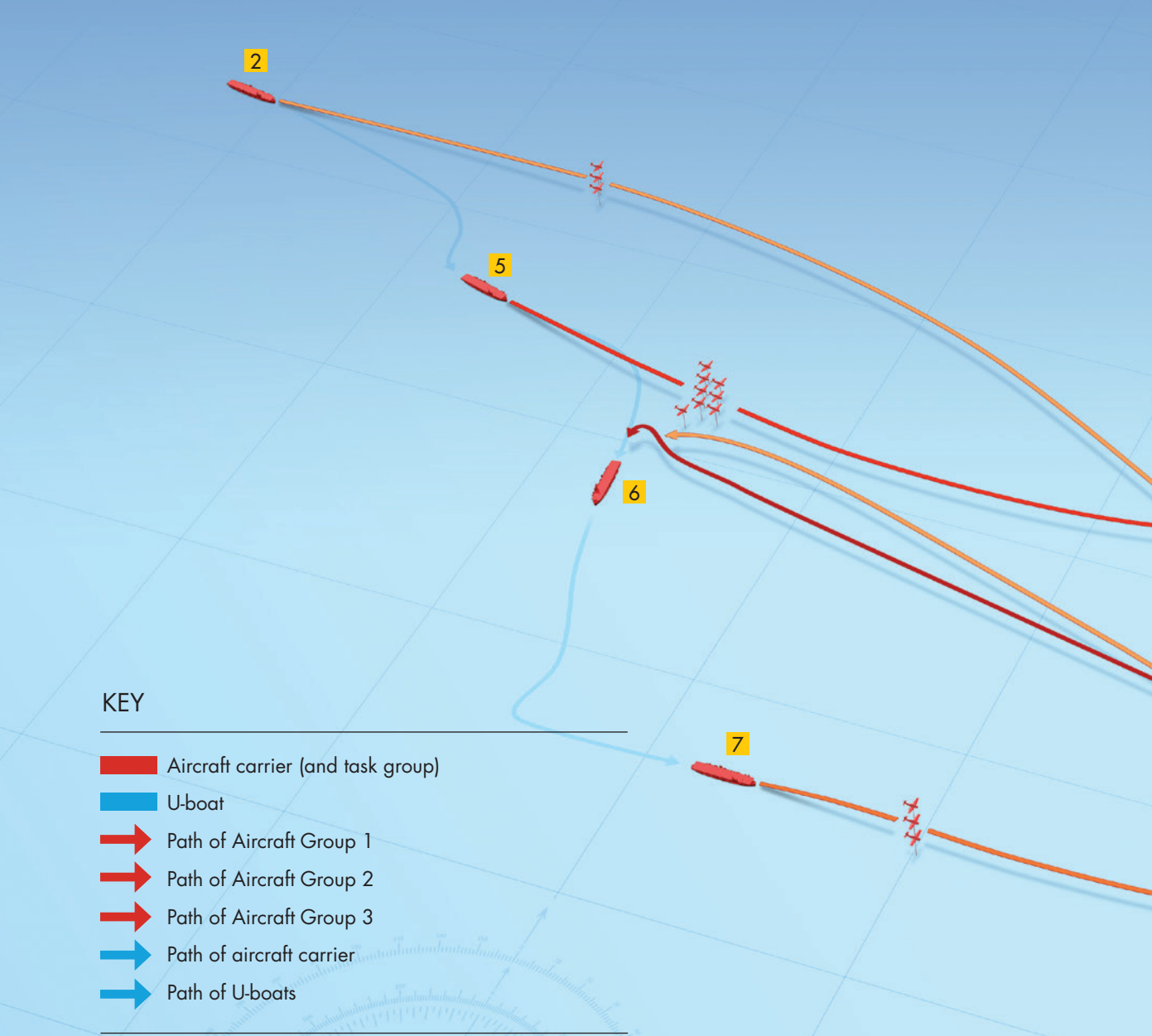
Dönitz attempted to counter aircraft by modifying Type VII U-boats into escort submarines, with very heavy anti-aircraft armament like the battery on this 'flak trap' U-boat. These boats were soon withdrawn due to ineffectiveness. (USNHHC)

Until May 1943, U-boats were ordered to submerge and remain submerged for 30 minutes if they spotted aircraft. Dönitz, though, had also increased anti-aircraft batteries on U-boats as one means of combatting aircraft and, in March, U-338 chose to slug it out with anti-aircraft guns, downing a Halifax. This encouraged other U-boats, especially those with improved anti-aircraft batteries, to do the same. By April, many



	Date	U-boat	Cause	Location
1	2-May-43	U-465	Aircraft	44.48N, 08.58W
2	4-May-43	U-109	Aircraft	47.22N, 22.40W
3	4-May-43	U-439	Accident	43.32N, 13.20W
4	4-May-43	U-659	Accident	43.32N, 13.20W
5	5-May-43	U-638	Warship	54.12N, 44.05W
6	6-May-43	U-125	Warship	52.30N, 45.20W
7	6-May-43	U-192	Warship	53.06N, 45.02W
8	6-May-43	U-438	Warship	52.00N, 45.10W
9	6-May-43	U-531	Warship	52.48N, 45.18W
10	6-May-43	U-630	Warship	52.31N, 44.50W
11	7-May-43	U-209	Aircraft	52.31N, 44.50W
12	7-May-43	U-447	Aircraft	5.30N, 11.55W
13	8-May-43	U-663	Aircraft	46.50N, 10.00W
14	10-May-43	U-381	Missing	53.22N, 36.61W
15	11-May-43	U-528	Aircraft & warship	46.55N, 14.44W
16	12-May-43	U-89	Aircraft & warship	46.30N, 25.40W
17	12-May-43	U-186	Warship	46.30N, 25.40W
18	12-May-43	U-456	Aircraft & warship	46.39N, 26.54W
19	13-May-43	U-753	Aircraft & warship	48.37N, 22.39W
20	14-May-43	U-640	Aircraft	60.32N, 31.05W
21	15-May-43	U-176	Warship	23.21N, 80.18W
22	15-May-43	U-266	Aircraft	45.28N, 10.20W

	Date	U-boat	Cause	Location
23	16-May-43	U-182	Warship	33.55N, 20.35W
24	16-May-43	U-463	Aircraft	45.57N, 11.40W
25	17-May-43	U-128	Aircraft & warship	10.00S, 35.35W
26	17-May-43	U-646	Aircraft	62.10N, 14.30W
27	17-May-43	U-657	Warship	58.54N, 42.33W
28	19-May-43	U-273	Aircraft	59.25N, 24.33W
29	19-May-43	U-954	Warship	54.54N, 34.19W
30	20-May-43	U-258	Aircraft	55.18N, 27.49W
31	21-May-43	U-303	Warship	42.50N, 06.00E
32	22-May-43	U-569	Aircraft	50.40N, 35.21W
33	23-May-43	U-752	Aircraft	51.40N, 29.49W
34	25-May-43	U-414	Warship	36.31N, 00.40E
35	25-May-43	U-467	Aircraft	62.25N, 14.52W
36	26-May-43	U-436	Warship	43.49N, 15.56W
37	28-May-43	U-304	Aircraft	54.50N, 37.20W
38	28-May-43	U-755	Aircraft	39.58N, 01.41E
39	30-May-43	U-418	Aircraft	47.00N, 14.00W
40	31-May-43	U-440	Aircraft	45.38N, 13.04W
41	31-May-43	U-563	Aircraft	46.35N, 10.40W
42	14-May-43	U-235	Air raid on port	Kiel
43	14-May-43	U-236	Air raid on port	Kiel
44	14-May-43	U-237	Air raid on port	Kiel



KEY

- Aircraft carrier (and task group)
- U-boat
- Path of Aircraft Group 1
- Path of Aircraft Group 2
- Path of Aircraft Group 3
- Path of aircraft carrier
- Path of U-boats

EVENTS

1 0901hrs. A Grumman Avenger from USS *Card* spots four U-boats together within 500 yards. U-460 has finished refuelling U-264 and is starting to refuel U-422. U-455 is waiting its turn. The Avenger reports the contact to *Card*.

2 0910hrs. *Card* launches two Wildcats and one Avenger to help the first aircraft.

3 0915hrs. The Avenger attacks, dropping a bomb between U-460 and U-284. All four U-boats return fire. U-460 submerges.

4 1000hrs. Group 2 aircraft reach the U-boats, strafing them, supressing the anti-aircraft fire and forcing the other three U-boats to submerge. As they submerge, the Avenger drops a Fido torpedo, which sinks U-460.

5 1038hrs. *Card* launches five more Avengers and three Wildcats (Group 3).

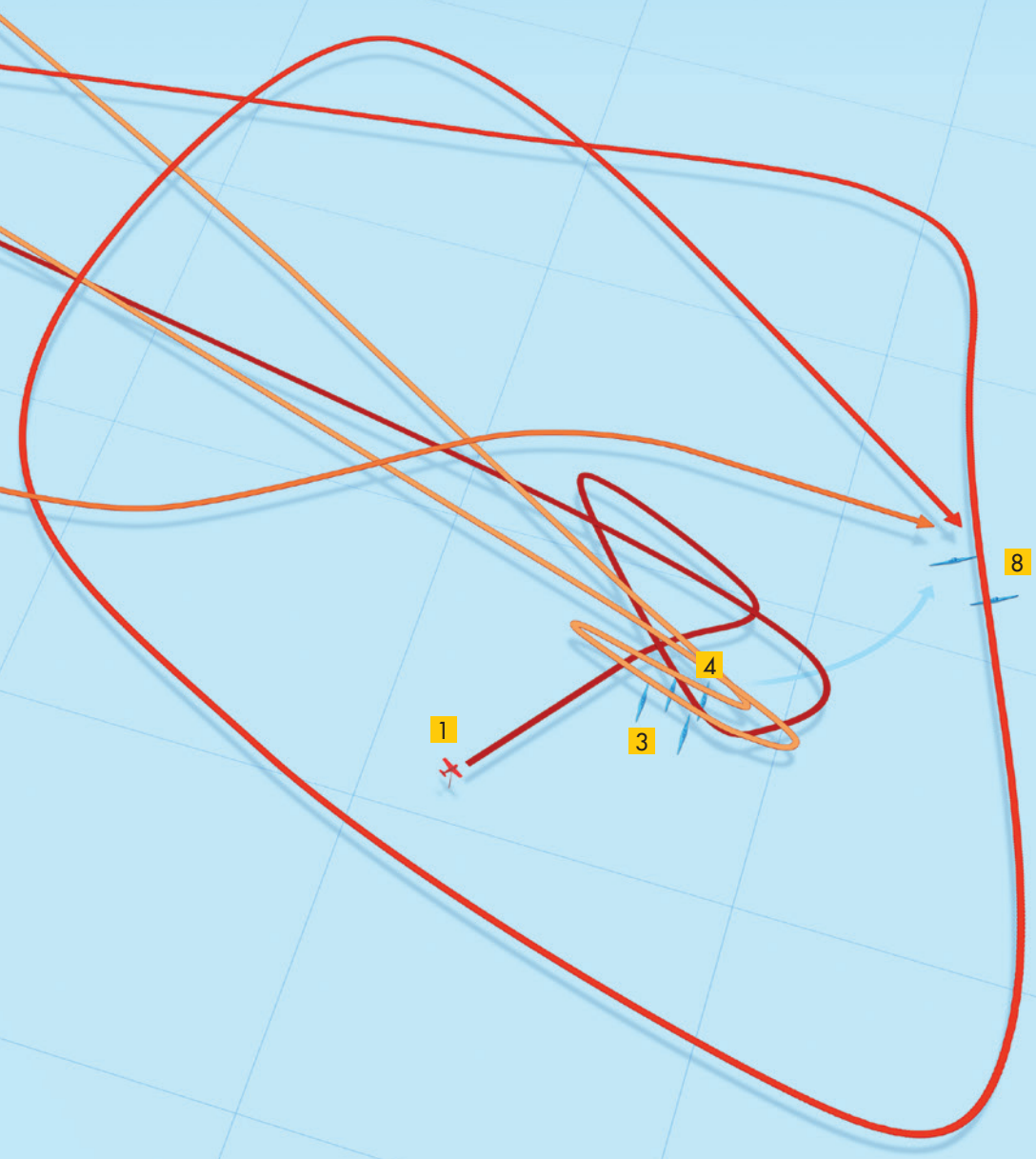
6 1200hrs (approximate). Group 1 and 2 aircraft return to *Card*.

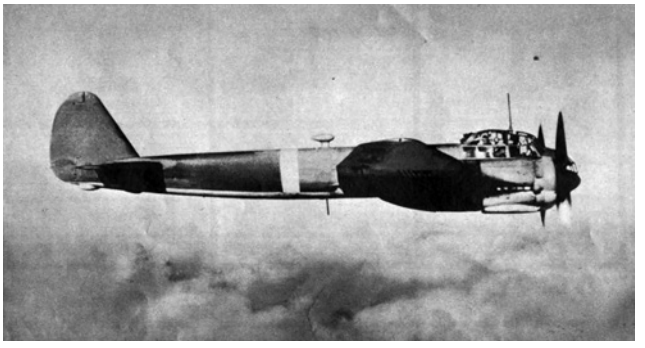
7 1330hrs (approximate). *Card* launches Group 2 aircraft on second patrol.

8 1600hrs (approximate). Group 2 and 3 aircraft find U-264 and U-422 on the surface and attack. They bomb and strafe U-264, damaging it badly enough to force it to abort its patrol, and sink U-422 with a Fido homing torpedo.

Card Catches Four

On 4 October 1943, aircraft from the escort carrier USS *Card* caught four surfaced U-boats south of the Azores. One was a milch cow U-boat tanker. The other three were taking supplies from it. The carrier's aircraft pounced, attacking all four and sinking two: U-460 and U-422.





Under pressure from Dönitz, the Luftwaffe began fighter sweeps with Ju-88 heavy fighters in the Bay of Biscay to hunt down Allied anti-submarine aircraft. They often used six to eight Ju-88s flying together. (AC)

U-boats were doing this and, on 1 May, Dönitz issued his 'Fight Back' order, directing U-boats to stay surfaced and fight when surprised by aircraft.

The biggest change, though, was the appearance of escort carriers. One British (HMS *Archer*) and one US (USS *Bogue*) began patrolling the Atlantic in the spring of 1943. Both were the core of an escort group with one escort carrier and several destroyers. They served as a rapid-response force, assigned to one convoy as it came under attack, switching to a new convoy once the first convoy reached the protection of shore-based aircraft.

They proved devastatingly effective. Carrier aircraft were smaller targets than multi-engine aircraft, and frequently faster. They broke up pack attacks before they could develop. Especially in the spring of 1943 when they caught U-boats by surprise on the surface in the mid-Atlantic gap, where aircraft had not been seen earlier.

USS *Bogue* made three patrols with convoys in March and April without sinking any U-boats, but bagged U-569 on 22 May. The next day, HMS *Archer*, the British carrier, sank U-752. It was the last U-boat for *Archer*, but *Bogue* went on to sink two more in June and nine more submarines (including two blockade-running Japanese submarines) over the rest of the war.

To balance the losses, U-boats sank 45 ships in May, just barely above a 1:1 exchange ratio. The largest fraction was lost by ONS-5, a slow convoy from Britain heading towards America at the beginning of May. It lost 13 ships sunk, most in the air gap, but the attack cost the Germans six U-boats in the battle, two others due to battle damage suffered while returning home and seven others so badly damaged they returned to port. It was the last major loss by a convoy to U-boats. Later convoy battles that month saw U-boats driven off for heavy losses and few kills. This, as much as heavy losses to aircraft, was why Dönitz suspended attacks against Atlantic convoys.

In June, Dönitz tried a new tactic to defeat Coastal Command's Bay barricade. He equipped several Type VII boats as flak traps, with heavy anti-aircraft batteries. These modified boats were not intended to conduct combat patrols but, in a role reversal, were intended to escort convoys of two to five other U-boats across the Bay from French ports. These transits were made surfaced, during daytime and at top surface speed. Once across, the flak traps returned to port, escorting any returning boats.

It worked at first, but Coastal Command pilots soon caught on. When a U-boat did not attempt to submerge when an aircraft appeared, the aircraft did not attack, waiting outside anti-aircraft range until joined by other aircraft. Then all would attack at once from different directions. Flak traps and the 'fight back' orders yielded greater opportunity to sink U-boats. U-boat convoys were abandoned; flak traps (those not sunk), were reconverted to duty as attack submarines.

Luftwaffe activity over the Bay grew in the spring of 1943, although it was not particularly well coordinated with Dönitz. Ju-88 fighters began flying sweeps over the Bay, often in groups of six to eight fighters. (In June, Ju-88s bagged a KLM DC-3 on a commercial flight to Lisbon carrying actor Leslie Howard.) While they shot down several Coastal Command aircraft, the Germans discovered that these were difficult targets, especially Liberators and Sunderlands. There were also occasional dogfights with Coastal Command Beaufighters seeking to protect Coastal Command aircraft.

The Luftwaffe also sent long-range patrol bombers to sweep the Bay, including FW-200s armed with radio-guided bombs. These were aimed at U-boat-hunting British support groups backstopping Coastal Command aircraft.

June ended with the loss of 16 U-boats (ten to aircraft) and only 21 Allied ships sunk. July was much worse. Coastal Command redoubled its Bay offensive and yet more escort carriers

joined the fight. Although U-boats sank 60 ships, in exchange 38 U-boats were lost, nearly three-quarters to aircraft. The Bay patrol sank 11 U-boats (one with help from a support group) and escort carrier aircraft sank six others.

Things also got worse for Dönitz in August, though with fewer losses. That month, Portugal agreed to let Britain base aircraft from airfields in the Azores, plugging the last large air gap in the Atlantic that shore-based patrol aircraft could not reach. The runways were initially too short to operate four-engine aircraft, but twin-engine Wellingtons and Hudsons could use them. By the end of the year, after US engineers (disguised as civilians) lengthened the runway, 30 Coastal Command Fortresses were also based there.

German fighter sweeps failed to stop the Bay of Biscay air patrols. Many anti-submarine aircraft, especially Liberators and Sunderlands, were well armed and proved to be difficult targets. These Sunderland waist gunners show one reason the Luftwaffe called the Sunderland the flying porcupine. (AC)

In August, 25 U-boats were lost, with three-quarters sunk by aircraft. In exchange, only 26 ships were sunk, an unacceptable loss ratio. Of those lost to aircraft, five were lost in the Bay and five to escort carrier aircraft. Still more were lost to aircraft in areas previously inviolate, including the Indian Ocean off Madagascar, and the South Atlantic off Africa.

This trend continued throughout the rest of 1943, as the patrol aircraft and escort carrier numbers increased. Even distant waters such as the South Atlantic and Indian Ocean were filled with aircraft. Dönitz attempted to resume North Atlantic convoy attacks in October, but aircraft checked the effort, sinking several U-boats in what had been the air gap. October was the high point of Allied ship losses in the last five months of 1943, with U-boats sinking 28 ships; losses were never above 25 in the other months. Milch cows were systematically hunted down and sunk, and Allied shipping losses, especially in convoys, were dropping. The end was in sight.

COASTAL COMMAND ORDER OF BATTLE – 31 MAY 1944		
Group 15 – HQ Liverpool		
Squadron	Base	Aircraft
86	Ballykelly	VLR Liberator
59	Ballykelly	VLR Liberator
201	Lough Erne (Castle Archdale)	Sunderland
422 (RCAF)	Lough Erne (Castle Archdale)	Sunderland
422 (RCAF)	Lough Erne (Castle Archdale)	Sunderland
Group 16 – HQ Chatham		
Squadron	Base	Aircraft
415 (RCAF)	Bircham Newton	Swordfish, Wellington
236	North Coates	Beaufighter
254	North Coates	Beaufighter
547	Thorney Island	Liberator
Group 18 – HQ Pitreavie Castle, Rosyth		
Squadron	Base	Aircraft
455 (RAAF)	Langham	Beaufighter
489 (RNZAF)	Langham	Beaufighter
333 (Nwy)	Sullom Voe	Catalina

210	Sullom Voe	Catalina
Group 19 – HQ Plymouth		
Squadron	Base	Aircraft
10 (RAAF)	Mount Batten	Sunderland
228	Pembroke Dock	Sunderland
461 (RAAF)	Pembroke Dock	Sunderland
172	Chivenor	Wellington
407 (RCAF)	Chivenor	Wellington
612 (RAuxAF)	Chivenor	Wellington
224	St Eval	Liberator
VB-103 (USN)	Dunkswell	Liberator
VB-105 (USN)	Dunkswell	Liberator
VB-110 (USN)	Dunkswell	Liberator
58	St David's	Halifax
502	St David's	Halifax
311 (Cz)	Beaulieu	Liberator
53	Beaulieu	VLR Liberator
304 (Pol)	Predannack	Wellington
248	Predannack	Mosquito
143	Portreath	Beaufighter
235	Portreath	Beaufighter
144	Davidstow Moor	Beaufighter
404 (RCAF)	Davidstow Moor	Beaufighter
AHQ Gibraltar		
Squadron	Base	Aircraft
202	Gibraltar	Catalina (MAD Cats)
48	Gibraltar	Hudson
233 (-)	Gibraltar	Hudson
179	Gibraltar	Wellington
AHQ Iceland		
Squadron	Base	Aircraft
120	Reykjavík	VLR Liberator
162 (RCAF)	Reykjavík	Canso
AHQ Azores		
Squadron	Base	Aircraft
206	Lagens	Fortress
220	Lagens	Fortress
233 (Det)	Lagens	Hudson
172 (Det)	Lagens	Wellington

ROYAL NAVY ORDER OF BATTLE – 31 MAY 1944 (only aircraft carriers involved in ASW activity)	
Escort Carriers These aircraft carriers operated a mixture of Swordfish and Avenger torpedo bombers and Martlet and Sea Hurricane fighters. Generally, but not always, they carried Swordfish and Martlets when on ASW duties. Between 15 and 25 aircraft were carried on ASW duties.	HMS *Biter* HMS *Activity* HMS *Chaser* HMS *Tracker* HMS *Fencer* HMS *Striker* HMS *Searcher* HMS *Pursuer* HMS *Emperor* HMS *Trumpeter* HMS *Nabob* HMS *Premier* HMS *Nairana* HMS *Vindex* HMS *Campania*
Merchant Aircraft Carriers (Merchant ships converted to operate aircraft while continuing to carry cargoes)	*Empire McKendric*[1] (4 Swordfish) *Empire MacRae*[1] (4 Swordfish) *Empire MacCallum*[1] (4 Swordfish) *Acavus*[1] (3–5 Swordfish) *Amastra*[2] (3–5 Swordfish) *Alexia*[2] (3–5 Swordfish) *Rapana*[2] (3–5 Swordfish) *Miralda*[2] (3–5 Swordfish) *Adula*[2] (3–5 Swordfish) *Empire MacKay*[2] (4 Swordfish) *Empire MacColl*[2] (4 Swordfish) *Empire MacMahon*[2] (4 Swordfish) *Empire MacCabe*[2] (4 Swordfish) [1] Grain Carrier [2] Black Oil Tanker

ROYAL CANADIAN AIR FORCE EASTERN COMMAND ORDER OF BATTLE – 31 MAY 1944		
HQ Halifax, Nova Scotia		
Squadron	Base	Aircraft
No. 113	Yarmouth, NS	Ventura
No. 119	Sydney, NS	Hudson
No. 145	Yarmouth, NS	Ventura
No. 160	Yarmouth, NS	Canso
No. 1 Group, St John's Newfoundland		
Squadron	Base	Aircraft
No. 5	Torbay, NF	Canso
No. 10	Torbay, NF	Liberator
No. 11	Torbay, NF	Liberator
No. 116	Gander, NF	Canso
No.5 Group, Gaspé Quebec		
Squadron	Base	Aircraft
No. 161	Gaspé	Canso

US NAVY		
Fleet Air Wing (FAW) 3, NAS Coco Solo, CZ		
Squadron	Base	Aircraft
VP-15	NAS Coco Solo, CZ	Coronodo
VP-84	NAS Coco Solo, CZ	Catalina
FAW 5, NAS Norfolk, VA		
Squadron	Base	Aircraft
VP-201	Bermuda	Mariner
VP-207	NAS Key West, FL	Mariner
VP-73	NAS Floyd Bennett Field, NY	Catalina
VP-74	NAS Elizabeth City, NC	Mariner
FAW 9, NAS New York		
Squadron	Base	Aircraft
VB-126	NAS New York, NY	Ventura
VB-129	NAS Quonset Point, RI	Ventura
VB-147	MCAS Cherry Point, NC	Ventura
VP-206	NAS Quonset Point, RI	Mariner
VP-214	NAS Norfolk, VA	Mariner
VP-215	NAS Bermuda	Mariner
VP-6 (CG)	Argentia, NF	Catalina
VB-126	NAS New York, NY	Ventura
VB-129	NAS Quonset Point, RI	Ventura
FAW 11, NAS Isla Grande, Puerto Rico		
Squadron	Base	Aircraft
VB-130	NAS Norfolk, VA	Ventura
VB-141	NAF Hato Field, Curaçao	Ventura
VB-143	NAF Hato Field, Curaçao	Ventura
VB-147	NAAF Carlsen Field, Trinidad	Ventura
VBP-128	NS San Juan, PR	Ventura
VP-204	NS San Juan, PR	Mariner
VP-205	NAAF Carlsen Field, Trinidad	Mariner
VP-210	NAS Guantanamo, Cuba	Mariner
VP-212	NAF Port of Spain, Trinidad	Mariner
VP-32	NAS Guantanamo, Cuba	Mariner
VP-92	NAF Hato Field, Curaçao	Catalina
FAW 12, NAS Miami, FL		
Squadron	Base	Aircraft
VB-113	NAAS Boca Chica, FL	Liberator
VB-125	NAF San Julian, Cuba	Ventura
VP-213	NAF Grand Cayman Island	Mariner

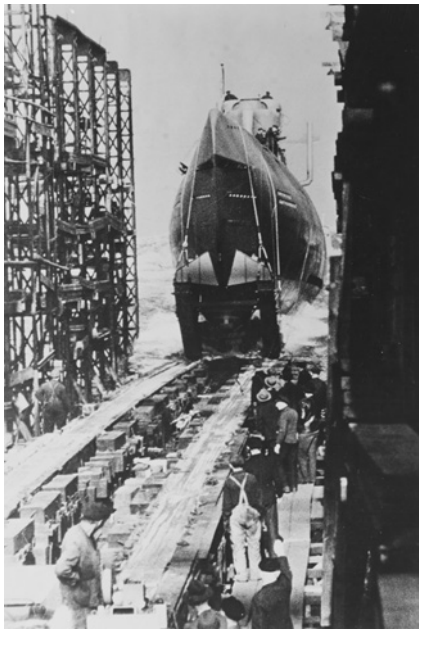
FAW 15, NAF Port Lyautey, FM		
Squadron	Base	Aircraft
VB-111	NAF Port Lyautey, FM	Liberator
VB-112	NAF Port Lyautey, FM	Liberator
VB-114	NAF Port Lyautey, FM	Liberator
VB-132	NAF Agadir, FM	Ventura
VP-63	NAF Port Lyautey, FM	Catalina
FAW 16, Recife, Brazil		
Squadron	Base	Aircraft
VB-107	Ascension Is	Liberator
VB-127	NAF Natal, Brazil	Ventura
VB-132	NAF Pici Field, Fortaleza, Brazil	Ventura
VB-145	NAF Natal, Brazil	Ventura
VP-203	NAF Galeão, Brazil	Mariner
VP-211	NAF Aratu, Bahia, Brazil	Mariner
VP-45	NAF Belém, Brazil	Catalina
VP-94	Ipitanga, Brazil	Catalina
Fleet Airship Wing 1, Lakehurst, NJ		
Squadron	Base	Aircraft
ZP-11	Lakehurst	Blimps
ZP-12	Lakehurst	Blimps
ZP-15	Glynco	Blimps
ZP-24	Weeksville	Blimps
Fleet Airship Wing 2, Richmond, VA		
Squadron	Base	Aircraft
ZP-21	Richmond, VA	Blimps
ZP-22	Houma, LA	Blimps
ZP-23	Jamaica	Blimps
ZP-24	Hitchcock, TX	Blimps
Fleet Airship Wing 4, Recife, Brazil		
Squadron	Base	Aircraft
ZP-41	São Luís	Blimps
ZP-42	Maceió	Blimps
Fleet Airship Wing 5, Trinidad		
Squadron	Base	Aircraft
ZP-51	Trinidad	Blimps

Aircraft Carriers (ASW in Atlantic only)	USS *Bogue* – VC-69 USS *Card* – VC-12 USS *Core* – VC-13 USS *Croatan* – VC-95 USS *Guadalcanal* – VC-8 USS *Solomons* – VC-9 USS *Wake Island* – VC-58 All VCs (composite squadrons) carried a mix of Wildcats and Avengers.

FORÇA AÉREA BRASILEIRA (BRAZILIAN AIR FORCE) ORDER OF BATTLE – 31 MAY 1944		
Unit	Base	Aircraft
1° GpPat	Belém	Catalinas
1° GpMA	Natal	B-25 Mitchel
2° GpBM	Salvador	Ventura
4° GpMA	Fortaleza	Hudson, B-25 Mitchell
1° GpBM	Recife	Ventura
3° GpBM	Galeão	Hudson, B-25 Mitchell
2° GpPat	Galeão	Catalina

The Atlantic battle won: January 1944–May 1945

The remaining 17 months of the Battle of the Atlantic were an anticlimax. The Allies could not believe they had actually won, and the Axis could not concede they had lost. Despite losing 244 U-boats in 1943, Dönitz pressed on, losing another 249 in 1944 and 120 during the last five months of the war in 1945. None of these losses changed the direction of the war in Germany's favour.



German shipyards launched the first Electroboot, Type XXI U-boat on 20 April 1944, but it took nearly a year for the first Type XXI to conduct a combat patrol. (USNHHC)

Germany's U-boat force theoretically hit maximum capability in January 1944. On 1 January, 436 U-boats were in commission, of which 87 were obsolete Type IIs or superannuated Type VII and Type IX boats relegated to school boat service. These boats could not be used in combat, and another 181 boats were working up. These were either conducting acceptance trials after commissioning or completing training. Only 168 were in combat theatres, including six Type IIs in the Black Sea, 13 boats in the Mediterranean and 19 in Norwegian waters. This left just 128 available in the Atlantic. However, this was not the total number of boats at sea; this was all boats, including those under repair or being modified.

Yet Dönitz continued in hopes of finding a solution that would allow him to win the tonnage war. He kept his obsolete Type VII and Type IX boats at sea hoping to tie down Allied forces until new, better, Type XXI and XXIII Electroboots could arrive.

As early as May 1943, Dönitz had realised the shortcomings of his current U-boats. In September 1943, Dönitz ordered 56 Type XXIII U-boats and, in November 1943, 163 Type XXIII boats. Until those arrived he planned to make do with the Type VII and Type IX boats. To give those a better chance at survival, he ordered Schnorchels be installed on these boats during refit and maintenance periods.

The first combat boat fitted with a Schnorchel was Type VIIC U-264, fitted with one in December 1943, but sunk on its first Schnorchel war patrol. Between February and May 1944, 35 U-boats were given Schnorchels and, in all, 151 boats were fitted with them during 1944.

Schnorchels were not war-changing weapons. U-264 as well as the next five U-boats fitted with them were all sunk during their first extended patrols. The boats could only travel at 6 knots while using the Schnorchel, as it broke at faster speeds, and they were limited to the view through the periscope. Furthermore, late-model radars could detect the Schnorchel head, and U-boats using Schnorchels were noisy and could not use passive hydrophones.

Nor did the Electroboots change much. The first was launched on 20 March 1944 and had so many problems (*Kinderkrankheiten* – teething problems, in German) that it did not go to sea for its acceptance trials until late summer. A handful of Type XXIs and Type XXIII U-boats *were* operational by 1945, but their operations were hampered by extensive Allied anti-submarine warfare defences. Electroboots sank a grand total of four ships for 7,400 tons in 1945, half of them in May.

The Allies, though, were in much better shape as 1944 began. They had a network of airfields and seaplane bases which permitted patrol aircraft to cover most of the North and South Atlantic, with airfields and seaplane bases ringing the coasts of the Indian Ocean permitting the sea lanes in that distant water to be protected too. (This was testimony as to the abundance of maritime patrol aircraft available, as this traffic was a distinctly minor part of wartime seagoing tonnage.)

KRIEGSMARINE ORDER OF BATTLE – 31 MAY 1944
1st Unterseebootsflottille (*Brest*)
VIIB: U-83, U-84,
VIIC: U-201, U-202, U-203, U-208, U-372, U-374, U-566, U-557, U-558, U-561, U-562, U-563, U-564, U-565, U-574, U-654
2nd Unterseebootsflottille (*Lorient*)
IX: U-38, U-43
IXB: U-103, U-105, U-106, U-107, U-108, U-109, U-123, U-124
IXC: U-66, U-67, U-68, U-125, U-126, U-127, U-129, U-131, U-502
Saldiray class (ex-Turkish): U-A
3rd Unterseebootsflottille (*La Pallice/La Rochelle*)
VIIC: U-212, U-242, U-262, U-275, U-333, U-373, U-423, U-466, U-483, U-596, U-671, U-719, U-953, U-970, U-971, U-975, U-992, U-993
6th Unterseebootsflottille (*St Nazaire*)
VIIC: U-228, U-260, U-269, U-270, U-290, U-385, U-437, U-445, U-608, U-672, U-673, U-742, U-758, U-766, U-967, U-981
7th Unterseebootsflottille (*St Nazaire*)
VIIC: U-255, U-267, U-281, U-285, U-382, U-390, U-427, U-667, U-714, U-985, U-988, U-1191, U-1191
9th Unterseebootsflottille (*Brest*)
VIIC: U-92, U-256, U-309, U-347, U-348, U-365, U-621, U-715, U-764, U-771, U-955, U-989, U-997
VIID: U-214, U-218
10th Unterseebootsflottille (*Lorient*)
IXC: U-510, U-516

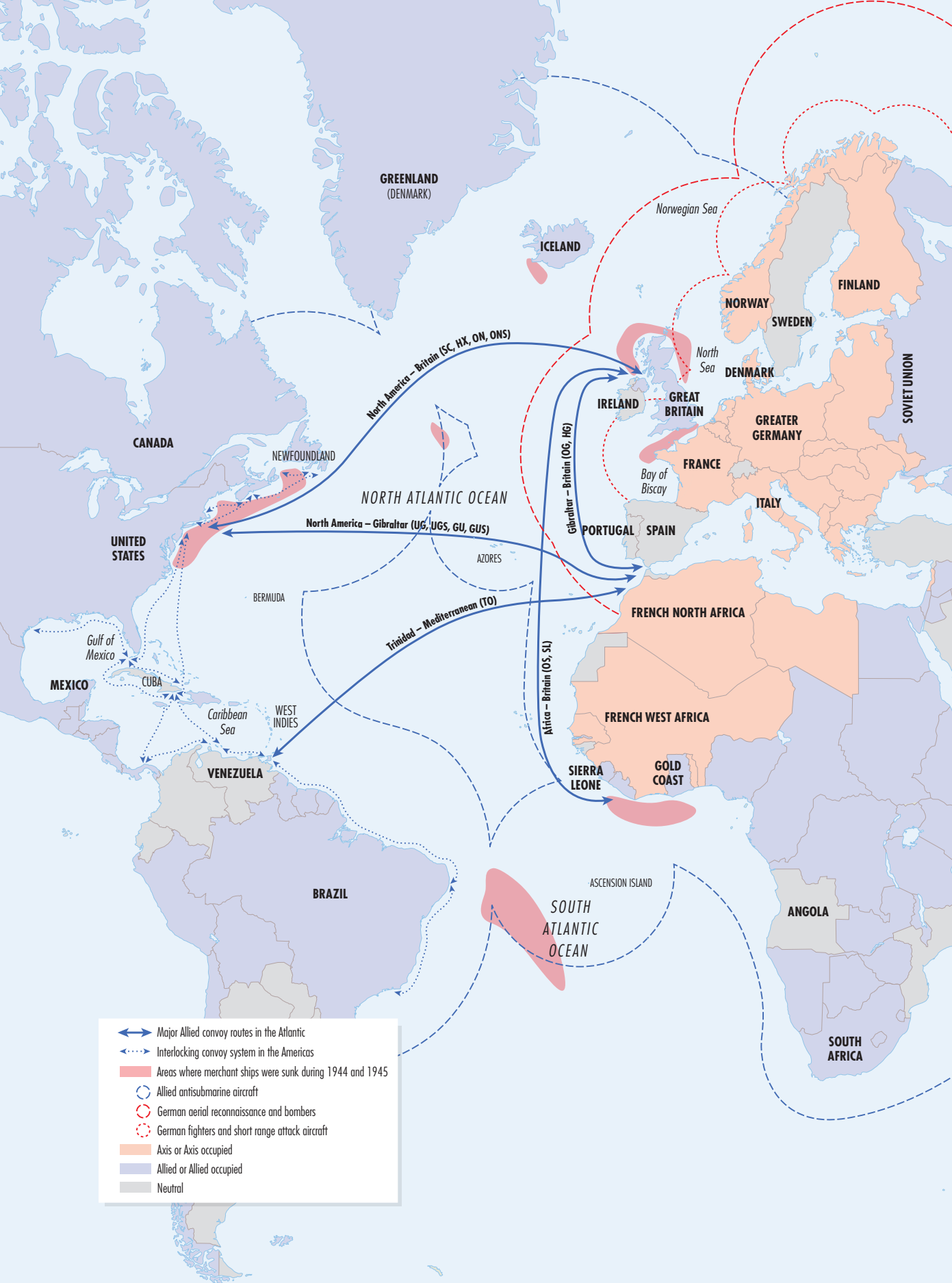
OPPOSITE STRATEGIC OVERVIEW: MAY 1944

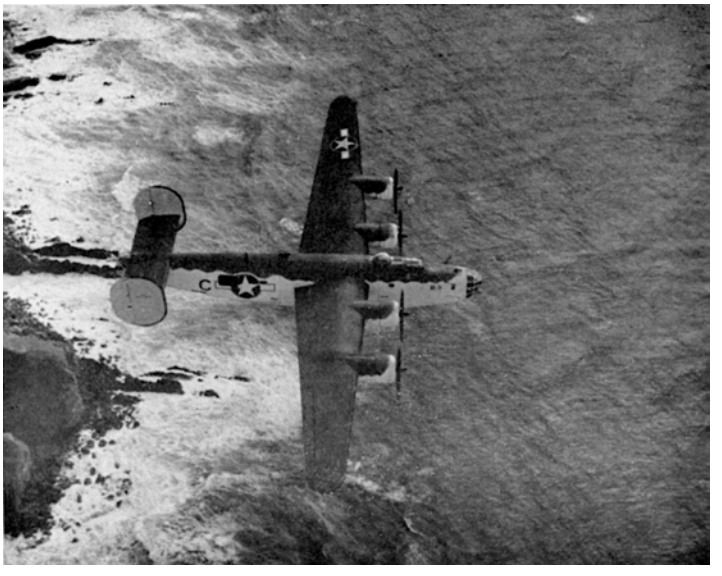
IXC/40: U-170, U-188, U-530, U-530, U-539, U-541, U-546, U-549, U-804, U-853, U-855, U-857, U-865, U-866, U-1222
11th Unterseebootsflottille (*Bergen*)
VIIC: U-278, U-312, U-313, U-315, U-354, U-427, U-716, U-956, U-957, U-965, U-987, U-989, U-997
12th Unterseebootsflottille (*Bordeaux*)
VIIF: U-1061, U-1061, U-1062
IXD1: U-180, U-195
IXD2: U-178, U-181, U-196, U-198, U-850, U-859, U-860, U-861, U-862
XB: U-219
XIV: U-490
Ex-Italian: UIT-24, UIT-25
13th Unterseebootsflottille (*Trondheim*)
VIIC: U-289, U-307, U-354, U-362, U-387, U-636, U-668, U-703, U-711, U-737, U-739, U-921, U-968

LUFTWAFFE		
KG 40	Bordeaux-Mérignac	FW-200, He-177, Ju-88
KG 26	Trondheim	Ju-88, Ju-188
KüFlGr-406	Kirkenes	He-115
KüFlGr-906	Brest and Tromsø	BV-138, He-115
SAGr-130[1]	Trondheim, Tromsø	BV-138
SAGr-131[2]	Stavanger	BV-138
ZG1	Lorient, Bordeaux	Bf 110, Ju-88C
[1] Was KüFlGr-706, re-formed into a Seeaufklärungsgruppe.		
[2] Was KüFlGr-406, re-formed into a Seeaufklärungsgruppe.		

Eleven Royal Navy and 11 US Navy escort carriers were available for convoy escort and U-boat hunter-killer task forces in 1944. Not all were used all the time for this, but enough were assigned to ASW duties at any one time to eliminate remaining air gaps in the Atlantic. By spring 1944 several carriers were conducting night operations with radar-equipped Avengers. This meant that U-boats were always at risk of attack by aircraft. Carrier operations were sometimes interrupted by winter storms in the North Atlantic, but, generally, weather bad enough to keep carrier aircraft grounded prevented coordinated U-boat attacks, too.

There were now more aircraft than ever. The AAF withdrew from anti-submarine warfare in April 1943, and shut down its last ASW squadrons, as well as the AAF ASW Command, in November 1943. It had been replaced by US Navy squadrons. Fleet Air Wing (Fairwing) 7 had three Liberator squadrons in Britain, supporting Coastal Command operations over the Bay. Catalinas equipped with MAD, belonging to Navy Patrol Squadron VP-63, operated out of Morocco, creating a MAD barrier across the Straits of Gibraltar. This effectively barred U-boat passage out of or into the Mediterranean. A detachment of VP-63's MAD-equipped Catalinas remained in England supporting Coastal Command.


GREENLAND
(DENMARK)
ICELAND
Norwegian Sea
FINLAND
NORWAY
SWEDEN
North Sea
DENMARK
SOVIET UNION
IRELAND
GREAT BRITAIN
GREATER GERMANY
CANADA
NEWFOUNDLAND
North America – Britain (SC, HX, ON, ONS)
Gibraltar – Britain (OG, HG)
FRANCE
Bay of Biscay
ITALY
NORTH ATLANTIC OCEAN
North America – Gibraltar (UG, UGS, GU, GUS)
PORTUGAL
SPAIN
UNITED STATES
AZORES
BERMUDA
FRENCH NORTH AFRICA
Trinidad – Mediterranean (TO)
Africa – Britain (OS, SL)
Gulf of Mexico
MEXICO
CUBA
FRENCH WEST AFRICA
Caribbean Sea
WEST INDIES
GOLD COAST
VENEZUELA
SIERRA LEONE
ASCENSION ISLAND
BRAZIL
SOUTH ATLANTIC OCEAN
ANGOLA
SOUTH AFRICA
Major Allied convoy routes in the Atlantic
Interlocking convoy system in the Americas
Areas where merchant ships were sunk during 1944 and 1945
Allied antisubmarine aircraft
German aerial reconnaissance and bombers
German fighters and short range attack aircraft
Axis or Axis occupied
Allied or Allied occupied
Neutral



Coastal Command operating out of Britain was reinforced heavily. The United States Navy placed Fleet Air Wing 7 in Britain, operating three Liberator squadrons out of the RAF Dunkswell airfield in Devon. (AC)

There were also VLR US Navy squadrons operating out of Newfoundland, Iceland, Bermuda, the Azores and Ascension Island by January 1944, as well as PBY and Mariner squadrons placed all over the Atlantic from Greenland to Rio de Janeiro. The Caribbean and east coast of the United States was patrolled largely by Ventura squadrons. The RCAF covered the eastern approaches to America with squadrons in Iceland, Newfoundland and Labrador.

Coastal Command was stronger than ever. It had 17 squadrons of VLR Liberators and long-range Catalinas, Sunderlands and Halifaxes operating out of Britain and Northern Ireland. There were five squadrons of Wellingtons, most equipped with Leigh lights. The twin-engine Hamptons and Whitleys had retired, and the remaining Hudsons withdrawn to theatres without air opposition. Twelve squadrons of Mosquitos and Beaufighters provided fighter protection to patrol aircraft and served as strike aircraft as needed.

Outside Britain, Coastal Command had a VLR Liberator squadron at Reykjavík, two Fortress, one Wellington squadron and a Hudson detachment in the Azores, and a Catalina, Wellington and two Hudson squadrons at Gibraltar. (These were the two remaining Hudson squadrons in Coastal Command. They would be retired from maritime patrol by the year's end with remaining Hudsons being used for meteorological and air-sea rescue purposes.)

Additionally, all air forces had effective weapons, with Fido and rockets in common use. Fido proved so effective that procurement totals were cut from 10,000 to 4,000. The other 6,000 were viewed as unnecessary. Similarly, many types of aircraft were equipped with rockets: Swordfish, Beaufighters, Liberators, Halifaxes and even the remaining Hudsons. Air-droppable depth charges were also plentiful and effective.

Electronic warfare was advancing, too. ASV Mark III radars (or US equivalents) were common, though, even more accurate than the 10cm sets, 3cm radars appeared in mid-1944. These could pick up a Schnorchel or periscope head. MAD was also being used operationally by 1944, mostly in Catalinas and US Navy blimps. So too were sonobuoys, further reducing the effectiveness of Schnorchels. Warship-mounted huff-duff directed carrier aircraft to U-boats by 1944 and, by January that year, the Allies had gained a numeric, material and technological advantage over the U-boats.

Another advantage the Allies had was an unbroken ability to read German codes. Thanks to the US's industrial capacity, bombes, devices used to break down and decode Enigma traffic, were being mass-produced. Allied codebreakers had sufficient computing power to swiftly recover keys when the Germans changed codes. Through the rest of the war the Allies read U-boat radio traffic in near-real time.

The Allies resumed Arctic convoys in November 1943 after a summer break. The first three slipped past Norway to reach Archangel or Murmansk undetected, as did the first three return convoys. The fourth outbound convoy of the season, code-named JW-55B, was attacked by both U-boats and a surface warship force containing the battleship *Scharnhorst*. The U-boats were driven off and the *Scharnhorst* was caught by the covering force and sunk in a duel with the British battleship *Duke of York*

By 1944 Naval Air Station Port Lyautey in French Morocco was one of the US Navy's most important anti-submarine bases. From it Madcat Catalinas sealed the straits of Gibraltar to U-boats, while PB4Y Liberators cut off U-boats heading for the South Atlantic or Indian Oceans. (USNHHC)

on Boxing Day, 26 December 1943. It marked the end of the Kriegsmarine as a surface force.

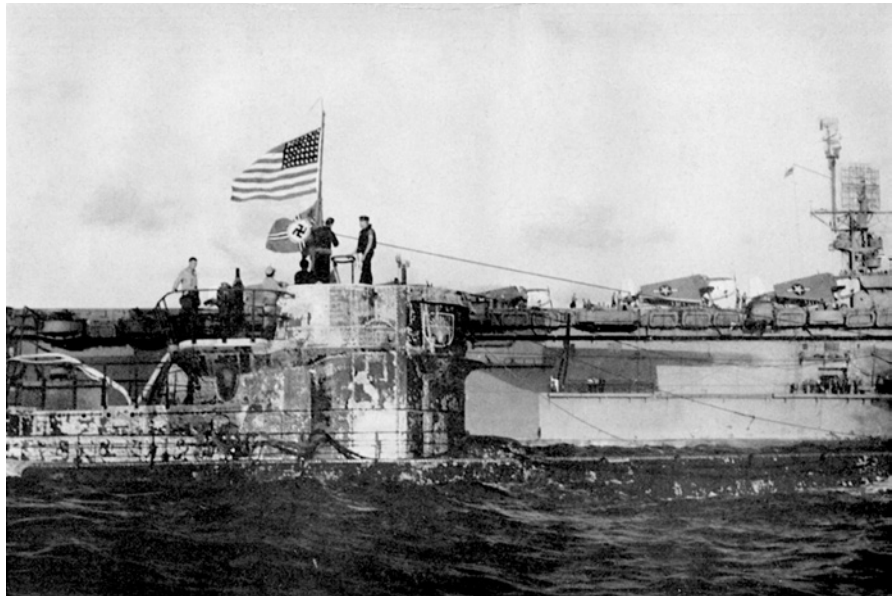
The next four convoys, sent at 10–30-day intervals, were all opposed by the Germans, largely through U-boats. Wolf packs of ten, 15, 14 and 16 U-boats respectively attacked each convoy. They sank only two escorts and four cargo ships (of 129 merchantmen sent) in all four convoys. One ship was sunk in the four return convoys. In exchange, six U-boats attacking the convoy were sunk. A seventh U-boat, returning from an Atlantic patrol, was also caught and sunk by the convoy escorts.

The final two convoys were accompanied by escort carriers. One U-boat was sunk by carrier aircraft and a second by a patrolling Coastal Command Catalina. The convoys were suspended in May due to the upcoming invasion of Europe, but were resumed in August 1944 and continued through to May 1945, with minimal losses thereafter.

Dönitz kept his Type VII U-boats in the eastern Atlantic in the first months of 1944 to have them at hand when the expected invasion of France across the English Channel occurred. He sent the Type IXs to distant locations, including a nest of boats sent to the Indian Ocean, operating out of Japanese-held Penang on the Malay Peninsula. He also sent individual Type IXs into the Caribbean, the US and Canadian coast, and the South Atlantic, near both Africa and South America. These were probing missions, testing anti-submarine defences in these areas.

The result was a split set of battles. The Type VIIs fought in the old Atlantic battleground of 1940 and 1941. The Type IXs fought in distant waters. Results were paltry and losses high. U-boats sank only 72 cargo ships between 1 January and 31 May. In exchange, 115 U-boats were sunk.

A large number of these losses were directly attributable to Allied codebreaking and direction finding, especially losses of Type IXs. Every time a U-boat transmitted, its position was noted by radio direction finding. If messages sent by the U-boat were decoded (and they usually were) the contents were added to the DF positions. Messages to U-boats were also decoded, and once a U-boat had been identified at sea, decoded messages to the U-boat were collected.



One remarkable example of cooperation between warships and aircraft was U-505's capture by a US Navy carrier task group. Aircraft found the U-boat, destroyer escorts forced it to the surface and a combined aircraft/warship attack led to its abandonment and capture. U-505 is pictured tied up next to escort carrier USS *Guadalcanal*. (AC)

The intelligence was collated in a Washington DC operations room and assessments of probable U-boat locations were generated daily. These assessments yielded advisories sent to appropriate airfields, hunter-killer groups and escort groups, informing them a U-boat might be in a specified location. Local commanders then swept the specified zones.

Commanders soon learned to treat these predictions as (in the words of Daniel Gallery commanding the *Guadalcanal* Task Group) 'the Bible truth'. Commanders were unaware of the source of the information – Gallery believed the operations room had an officer who would 'put himself in the position of a German skipper and just figure out what the guy was going to do and where he would go'.

Regardless, intelligence reports allowed escort carrier task groups to have aircraft arrive with uncanny accuracy at mid-ocean U-boat rendezvous, or position themselves in the path of a U-boat sailing out or returning to patrol locations. The most famous example occurred on 4 June 1944 when a task group containing *Guadalcanal* trapped and captured U-505, a Type IXC U-boat, returning to France at the end of its twelfth combat patrol.

It was not the only example. Most kills racked up by US Navy carrier task groups could be chalked up to similar advisories. Increased kills by convoy escorts could also be attributed to the warnings provided.

The Germans could, however, occasionally strike back. U-549 torpedoed and sank *Block Island*, a Bogue-class carrier, on 29 May 1944. U-549 then used a GNAT to torpedo one of *Block Island*'s escorts, the destroyer escort *Barr*, while trying to escape after sinking *Block Island*. U-549 was then sunk by the *Eugene E. Elmore*, another destroyer escort in the screen.

The D-Day invasion proved disastrous to those U-boats which had survived until June. Starting on 1 April, Dönitz recalled around 50 Type VIIs in the Atlantic to French bases to oppose the then-imminent invasion. Thirty more Type VIIs were gathered in Bergen, Norway, while another 30 Type VIIs in the Arctic were alerted to support the Bergen boats when an invasion took place. These boats could be reinforced by 20 to 30 Type VIIs in the Baltic, though only one-third of these were equipped with the Schnorchels necessary for survival by May 1944.

Allied intelligence estimated the German U-boat strength at 120, including up to 50 high-speed Walter boats. Although an error, it worked against the Germans as it caused the Allies to plan saturation anti-submarine warfare efforts, including 375 aircraft, most equipped with

3cm radar, and the larger aircraft equipped with sonobuoys. These were backed up with naval surface escorts and three Royal Navy escort carriers.

The U-boats moved into a perilous situation. Before the invasion saboteurs cut all landline communication with the French U-boat bases, so only radio communication (subject to interception) was available. Thirty-six boats were ordered to the invasion area starting the day after the 6 June invasion had started. By 11 June, five non-Schnorchel boats had been sunk, and five more were badly damaged and forced back to port. The rest of the non-Schnorchel boats were ordered to form a defensive line in the Bay of Biscay. All were forced under, several badly damaged, and U-boat control ordered them home on 12 June.

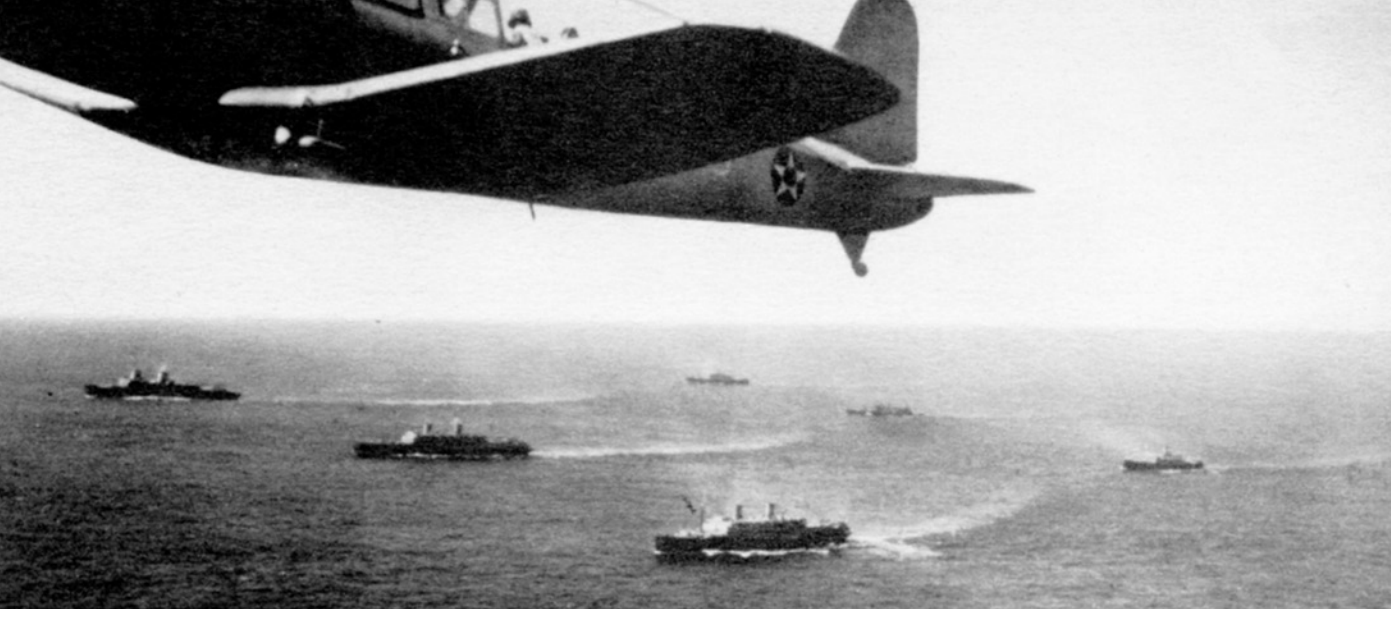
Fourteen Schnorchel-equipped boats sent out on 7 June had slightly better luck. In the most tonnage-rich patch of ocean during all of World War II they only sank three warships and five cargo ships (for 25,000 tons), and damaged a warship and two freighters. In exchange, three U-boats were sunk and three others badly damaged. Follow-up waves of U-boats did little better. In all cases, the U-boats were sunk by aircraft, most before reaching the English Channel.

The rest of 1944 followed this trend. When 1944 ended, 231 U-boats were lost to all causes, nearly half to aircraft. Against that loss, 208 merchant ships totalling just under 1 million tons were sunk in 1944. And 1945 was no better. In the war's last five months, from January to May 1945, only 98 ships were hit by U-boats, of which 84 were sunk. Of these, one-quarter were small anti-submarine warships.

By October 1944, the French and Mediterranean U-boat ports had been lost, leaving only the bases in Norway and Germany. Attacks were being made primarily by Schnorchel-equipped boats, largely operating submerged. Travel times were slow, limiting the Type VII boats (and the very few Type XXIII boats) on combat patrols to travel no further than the Irish Sea.

Most casualties inflicted by U-boats from July 1944 through to the war's end were in waters around the British Isles, in the North Sea, the Baltic and the Arctic. A few ships were sunk off the North American coast, in the Indian Ocean and South Atlantic, but they were insignificant. In many ways, except in the Arctic, Allied ship losses followed the geographical pattern of 1939, often for the same reasons: U-boat base locations. The difference was that in 1939 aircraft were scarecrows, unable to sink U-boats, but by 1945 they had become the U-boats' most deadly predator, for which no remedy could be found.

The Allies set up an impenetrable curtain of anti-submarine aircraft and warships around the English Channel during the Normandy invasion. These Sunderlands are photographed along the Channel coast in 1944. (AC)



AFTERMATH AND ANALYSIS

The biggest mistake made by the Allies was the US Navy's refusal to form weakly escorted convoys along the Atlantic coast. Even convoys guarded only by inadequate air escort, like this OS2U Kingfisher, would have cut losses by reducing opportunity for U-boats to find merchant vessels. (AC)

The war ended with a whimper for Germany's U-boat force. Of the nearly 400 U-boats still in commission on 8 May 1945, 222 were scuttled to prevent their capture, 168 surrendered to the Allies and seven in Japanese-controlled ports were seized by Japan. (The vessels seized by Japan included two ex-Italian submarines the Kriegsmarine took after Italy's surrender. Subsequently turned over to the United States when Japan surrendered, they must hold a record for the most times a warship was surrendered in a single war.) Between 9 May and 15 May, most U-boats on patrol when the war ended arrived at Allied-controlled ports and surrendered. Two U-boats, U-530 and U-977, ignored orders to surrender to Allied powers, sailing instead to Argentina to surrender. The last, U-977, surrendered in August 1945, after Japan's surrender.

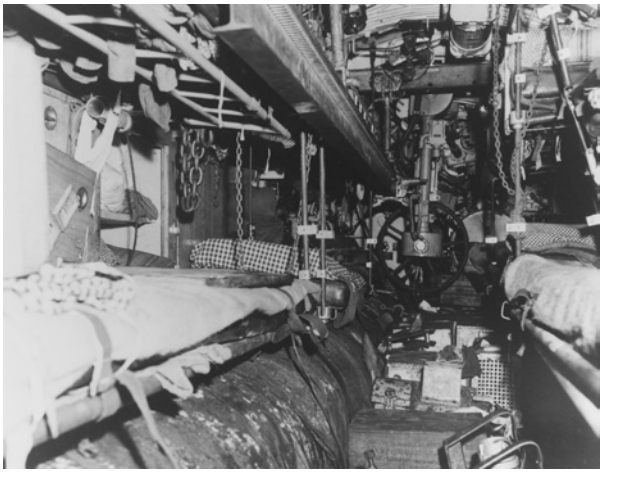
Dönitz ruled Germany for just 20 days. Thereafter, the occupying powers dissolved the Nazi government and arrested Dönitz. He stood trial for war crimes. A new German government was established, and Dönitz was convicted and served ten years. Unrepentant about his role, after release Dönitz insisted he was the last legitimate head of the German state. He died in 1980.

While the Battle of the Atlantic and the war in Europe ended, World War II had not. Japan was still at war and so Atlantic anti-submarine resources were shifted to the Pacific, to assist in the invasion of Japan. (Japan's submarine force was already neutralised with sufficient anti-submarine forces present in the Pacific.) Much of this was still in planning when Japan surrendered in August 1945. Few aircraft or personnel actually moved. Units were demobilised, aircraft were sent to storage, sold as surplus or scrapped, and bases were either closed or reduced. The process was complete when 1946 ended.

Some surviving aircraft soldiered on in peacetime navies, armies and air forces in anti-submarine or maritime reconnaissance squadrons for years after the war's end. The Sunderland, originally introduced in 1937, stayed in RAF inventories until 1959. The Royal New Zealand Air Force was the last nation to use them, retiring the last in 1967 – three decades after they were first introduced. The Catalina did even better. First used by the

US Navy in 1937, US Navy reserve units continued using them through to 1957. The Brazilian Air Force kept some in service until 1979. The Mariner, the last flying boat introduced (in 1940) departed sooner, with the US Navy retiring its last Mariner in 1956 and the last nation to use them, Uruguay, ceasing to use them in 1964.

The Wildcat/Martlet and Swordfish were abandoned as operational aircraft almost immediately after World War II ended, although the Avenger lasted longer. It served in the US Navy through to the end of the Korean War, retiring in 1954, but other navies, including Japan's Self-Defense Forces, used it throughout the 1950s. The last ones were finally withdrawn in the early 1960s, its post-war career having been primarily as an anti-submarine aircraft rather than as a torpedo bomber.



Life aboard U-boats was dangerous, crowded and squalid. Lack of space forced crew to berth where they worked. The food was wretched, and sanitary conditions primitive. Sailing-era sailors enjoyed better living conditions. (USNHHC)

The U-boats fared less well. In Operation *Deadlight*, 116 U-boats were sunk. Between 14 November 1945 and 12 February 1946, they were taken from their post-surrender collection ports in Scotland and Northern Ireland, and were sunk in the Northwestern Approaches to Great Britain. The trail of the scuttled submarines parallels the route of North Atlantic convoys approaching or departing Great Britain between 1941 and 1945.

Thirty other captured U-boats were divided, ten each, between Britain, the United States and the Soviet Union. Britain and the United States quickly disposed of their allocated U-boats – they were either sunk shortly after being obtained (generally as targets), tested to destruction, or (more rarely) briefly incorporated into the navy or used for training or testing. All were gone by 1951, most by 1948.

The Soviets incorporated their allocation, including five Electroboots, into the Soviet Navy, where they served until the mid-1950s. Thereafter they were scrapped or expended in atomic bomb tests. One of the ten lasted until 1968 before being scrapped. The French Marine Nationale and Norway's Navy commissioned several former U-boats in their post-World War II fleets, and the Netherlands recovered one of its boats taken as a prize by Germany. These served into the mid-1960s, but all were scrapped by the end of that decade.

Numbers vary, but over 760 U-boats were lost to all causes during World War II. Nearly 500 were sunk by Allied aircraft and warships while the U-boats were on patrol, and another 39 were destroyed by Allied bombing raids on ports and shipyards (all but one after 1942). Of the U-boats sunk at sea, 243 were sunk solely by aircraft, 240 by Allied warships and 42 sunk by a combination of the two.

In most cases where aircraft and warships shared a kill, the U-boat was first detected by an aircraft which directed nearby warships to its position – a reasonable case could therefore be made that aircraft were primarily responsible for 285 of the 489 U-boats Allied armed forces destroyed at sea. Including U-boats lost in bombing raids, aircraft accounted for 324

The Grumman Wildcat (or Martlet in Royal Navy service) was the main carrier fighter aircraft used in the Battle of the Atlantic. They saw active service from 1941, when the Royal Navy first used them, until the defeat of Germany. (AC)

A common sight in the Atlantic during 1943–45: an anti-submarine aircraft circling an oil slick created by a U-boat attacked by aircraft. (AC)

of 528 U-boats destroyed in combat. Depending on how things are scored, aircraft were responsible for 50 to 61 per cent of all combat losses of U-boats.

What makes the percentage more remarkable is that aircraft accounted for only seven U-boats between 1939 and the end of 1941. During the period covered by this book, aircraft were responsible for 54 to 68 per cent of all U-boats destroyed in combat: half to two-thirds.

This does not trivialise the contribution made by warships. Many of the kills by aircraft were facilitated by information provided by warships, including sighting reports and huff-duff bearings. Warships were also better close-in protection for convoys than aircraft, and could operate in weather conditions impossible for aircraft. More importantly, once they found a U-boat, warships could pursue it to death, maintaining contact until the U-boat was sunk or forced to surface due to lack of battery power and oxygen.

Aircraft could not do that. With few exceptions (blimps) they lacked the endurance to pursue submerged U-boats and, unless MAD-equipped (blimps and Madcat Catalinas) or deploying sonobuoys, could not detect submerged U-boats. Aircraft excelled at covering large areas of ocean quickly, and making quick hit-and-run attacks against surfaced U-boats. This was doubly true even if the U-boat submerged while being attacked. By 1943 depth-charge doctrine and the Fido torpedo meant a U-boat that submerged while under attack was almost as – if not more – likely to be sunk than one that fought it out on the surface.

Important contributions made by aircraft went beyond sinking U-boats. They also destroyed the ability of wolf packs to make coordinated attacks on convoys. Their ability to scout out the area far ahead of and around convoys forced U-boats to submerge – a submerged U-boat's scouting horizon was then reduced to periscope height and they could not communicate, making it more difficult to find a convoy. Even when they did, they could not communicate the find.

They also prevented uninterrupted surface operations remote from convoys. The milch cows were needed to resupply combat U-boats on the surface, so aircraft hunted down and destroyed most milch cow supply U-boats, crippling the ability to operate Type VII boats in the southern North American coasts, West Indies and Gulf of Mexico, and restricting resupply in the northern North Atlantic.

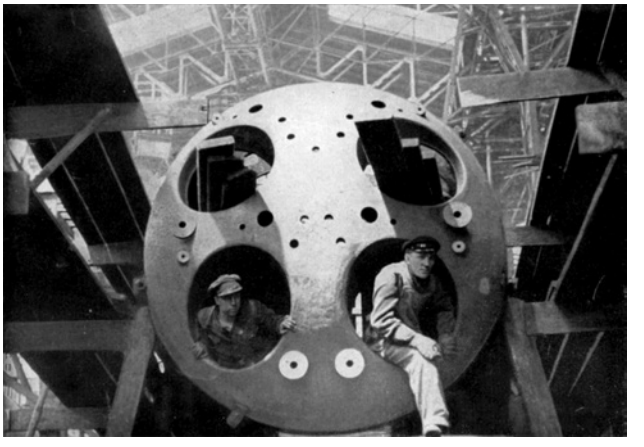
Similarly, forcing U-boats to cross the Bay of Biscay submerged (and later the entire North Atlantic) wasted their time, fuel and supplies. By 1945, Schnorchel-equipped boats were forced to cross to the American coast entirely submerged, travelling no more than 6 knots during the four to five hours of recharging the batteries submerged, and operating the rest of the day on batteries at 2 knots. It was no way to win a tonnage war.

Avoiding aircraft by staying submerged increased U-boat vulnerability to surface warships. They were deaf and blind while running diesels under Schnorchel. In March–May 1945, the US Navy, learning Dönitz was dispatching U-boats to the American coast, instituted Operation *Teardrop*. This teamed escort carrier groups with 20 additional destroyer escorts on a 120-mile picket line across the mid-Atlantic. The barrier force swept a line across the U-boat approach routes, and found and sank all six boats sent. The kills were all accomplished by destroyer escorts, but the operation was possible only due to the carrier aircraft keeping the U-boats submerged and slow.

The score was not one-sided of course. During World War II, U-boats shot down nearly 120 aircraft. Coastal Command lost 741 aircraft on anti-submarine duty to all causes from

1939 to 1945. The other Allied air forces (US, Canadian, Brazilian and Free French) probably lost a similar number between 1942 and 1945. Weather and accidents accounted for most losses.

Exchanging 760 U-boats for twice that number of anti-submarine aircraft was an unfavourable exchange rate. Aircraft could be produced in tens of thousands but U-boat production barely exceeded 1,100. By 1944, it took an hour to build a Liberator; it took between five and seven months to build a Type VII U-boat. If the Allies lost ten aircraft for each U-boat sunk, the exchange rate still grossly favoured the Allies.



There were too few U-boats at sea during the critical first six months of 1942. Slow production rates were part of the problem as U-boats took nearly a year to build. Long workup and training periods also kept U-boats out of battle. (AC)

Even adding in the 170 anti-submarine warships sunk by U-boats to the total Allied aircraft lost does not balance the scales. The Allies could produce ten ASW ships (including subchasers and patrol craft) for every U-boat built. (They did not, because there was no need. ASW ship production was slashed in 1944 due to surpluses.)

U-boats existed to sink merchant ships and sink them in large numbers, not sink escort warships or shoot down aircraft. Dönitz's tonnage war was based on that. Ultimately they failed in that, as well. U-boats managed to exceed sinking 6 million tons of merchant shipping annually only once in the years between 1942 and 1945. That was in 1942, with 6.15 million tons of Allied shipping sent to the bottom.

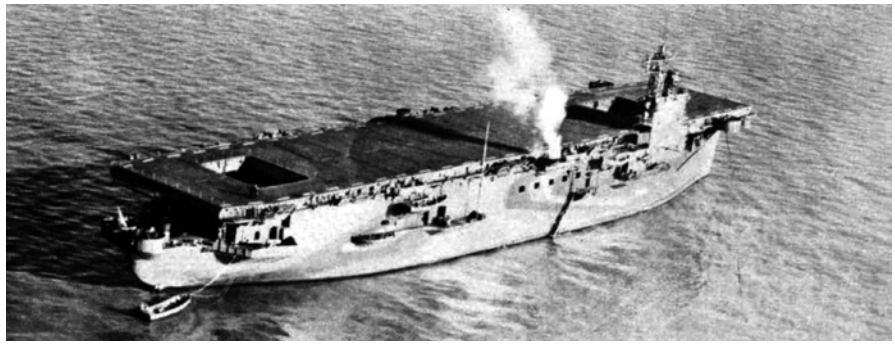
During that year the Allies produced over 7 million tons of new shipping, ending the year with 1 million more tons than they began. Thereafter, the balance shifted dramatically. U-boats sank 2.5 million tons of shipping in 1943 and 663,000 tons in 1944. Meanwhile, Allied shipbuilding production soared. By 1945 it was capable of producing over 12 million tons of merchant shipping a year – the only thing stopping the growth of the Allied merchant marine was the war's end in August 1945.

Could the Germans have won the Battle of the Atlantic? It was possible, barely, but it would have had to be won in 1942. Had the U-boats not interdicted transatlantic communications by the end of 1942, the Allied production advantage would – as it did during the war – have overwhelmed Germany's U-boats. It would also have required the Allies to make significant mistakes.

The biggest obstacle to German success was the convoy system, which had already defeated Germany in World War I. Although Dönitz's wolf-pack tactics were successful in overwhelming convoys in 1940 and early 1941, its effectiveness was fading as 1942 began. Radar and huff-duff cancelled the ability to use darkness to make surface attacks against convoys.

US Navy doctrine was correct: a strong escort prevented effective attacks against convoys. Over 1,100 convoys crossed the Atlantic between January 1942 and May 1945. Over that period only 21 convoys lost six or more ships. The two biggest losers were Arctic convoys: PQ-17 with 24 ships lost and PQ-18/QP-14 which lost 19. No transatlantic convoy lost more than 14 ships. Even during 1942, only ten transatlantic convoys lost more than six ships. Since convoys contained at least 35 ships in 1942 (and 60 or more in subsequent years), even in the worst-hit convoys most ships arrived safely.

As in World War I, during 1942 the real slaughter took place among unescorted shipping sailing individually, and there was no convoy system along the US coast in January 1942. Coastal convoys were not started until May 1942, and the Interlocking Convoy System only began operating in August. Not until the end of 1942 was there a comprehensive convoy system. Thereafter, losses to U-boats plunged.



The Allies mass-produced aircraft and warships, even warships as large as escort carriers. This Attacker-class escort carrier was one of 45 built (including the near-sister Bogue and Ruler classes). They were followed by 50 Casablanca-class and 35 planned Commencement Bay-class carriers. (AC)

Convoy effectiveness was masked by the increased number of U-boats at sea throughout 1942. There were only 33 U-boats on patrol on 1 January 1942, 75 in May (when coastal convoys started) and 118 on 1 September (after the Interlocking Convoy System was introduced). The total remained over 100 from 8 August 1942 until the end of the year. Yet, while the number of U-boats at sea over the last half of 1942 was triple the number in January and February, monthly ships sunk over the last half of the year only doubled the January and February monthly sinkings.

Had Dönitz made a maximum effort against North American waters in January–April 1942, he would likely have tripled the sinking in those months. Instead of 290 ships for 1.6 million tons of shipping, it might have been closer to 900 and 4.8 million tons, but it would have required tripling the number of U-boats in US waters during those months.

This was barely possible. There was an average of ten Type IX and 15 Type VII boats per month patrolling American waters during those months. During that period there were 20-odd U-boats in the Arctic, guarding against an imaginary Allied invasion of Norway. Another 13 boats that had been in the Atlantic when Germany declared war on the United States were ordered to the Mediterranean in December and January. With those boats, Dönitz could have more than doubled the patrols to American waters. Shifting a few boats from the eastern Atlantic and speeding up repairs and maintenance on others might have freed up enough boats to make up the difference.

The effects would have been temporary. Allied losses would have dropped as convoys were introduced and by August Allied losses would have dropped to levels seen historically. Additionally, it assumes the Allies took no additional anti-submarine measures in early spring, such as committing more aircraft to the American theatre.

The Allies made mistakes too. The biggest was the refusal to introduce coastal convoys earlier. This was based on US Navy doctrine that a weakly guarded convoy was worse than a well-defended convoy. While true when dealing with wolf-pack tactics, when U-boats patrolled independently, forming weakly guarded convoys reduced U-boats' opportunities to find shipping. Even once found, there were limits on how many ships a U-boat could sink with one attack, and aircraft could have beefed up the escort. German policy then was to submerge if an aircraft were spotted; even unarmed aircraft offered protection. Since the US was unaware the Germans would not use pack tactics or would flee at the sight of an aircraft, this is being wise after the fact.

The biggest problem Dönitz had, once the Allies learned how to use aircraft effectively against U-boats, was the Allies' industrial capability. They could quickly develop anything they needed – airborne radar systems, Fido torpedoes, blimps, escort carriers, and then produce them in massive quantities. More than that, they could adapt to changing conditions, develop doctrine and change tactics faster than the Germans could.

This was built into the governmental and economic structures of the two sides. The Allies, especially the United States, but also Britain, had traditions of decentralised government and

free-market economy, but the Axis were committed to centralised governance with command economies. Good ideas and weapons percolated through the Allies faster than they did with the Axis – the Allies always operated inside Germany's decision loop. In a very real sense, the U-boats never had a chance to win.

Surviving U-boats and aircraft

Three U-boats that saw combat between 1942 and 1945 exist today: one Type VII and two Type XIs. A fourth boat, Type XXI U-2540, which never saw combat and was scuttled in 1945, was subsequently raised in 1957. It is now on display at the Deutsches Schifffahrtsmuseum in Bremerhaven.

The most famous combat veteran, U-505, a Type IXC U-boat captured by a US Navy hunter-killer group in 1944, is preserved as a museum ship. It has been on display at the Museum of Science and Industry in Chicago, Illinois, since March 1954.

The second, U-995, a Type VIIC/41 with nine combat patrols to its credit, was surrendered at Trondheim in May 1945. It was commissioned in the Norwegian Navy as *Kaura* in 1952, served until 1965 and returned to Germany where it became a museum ship at the Laboe Naval Memorial in 1971.

A third, U-534, was a Type IXC/40. It conducted three war patrols, sank no ships and was sunk by a Coastal Command Liberator on 5 May 1945. It was raised in 1993 and taken to Birkenhead, England, in 1996 where it was restored. It is on display at the Woodside Ferry Terminal in Woodside, England.

There are rather more surviving Allied aircraft of types used for anti-submarine warfare during these years. Many of these aircraft, especially Hudsons, Catalinas and Cansos were converted to civilian use post-war.

Eleven Hudsons still exist, with six in storage or undergoing restoration, four on static display and one airworthy. Only one is in the UK. The rest are in Commonwealth nations, with six in New Zealand. Over a dozen Liberators are preserved in various museums, although none appear to have served in anti-submarine service. The Catalina has nearly 90 preserved examples including 24 Canadian-built Cansos (licensed-built copies of the Catalina) with three on display in Britain. A bare half-dozen Sunderlands are still around, at least one of which participated in the Battle of the Atlantic. One is reported to be in flying condition.

Nearly two dozen Venturas exist, including an upgraded version, a PV-2 Harpoon, on display at the National Naval Aviation Museum in Pensacola, Florida. Only one Mariner exists, a type built post-war. It is at the Pima Air and Space Museum in Tucson, Arizona. No complete Whitleys survive, and the three surviving Halifaxes and two surviving Wellingtons were Bomber Command aircraft.

The Fleet Air Arm has fewer surviving examples of aircraft that fought in this period. Twelve Swordfish exist, of which three or four are airworthy. Six are on display at various museums: three in Britain, one in Canada, one in Malta and one in Texas. None are known to have operated in the Battle of the Atlantic circa 1942–45. Over 40 different Wildcats remain, including two Martlets on display in England and half a dozen FM-2s (the type that served on US Navy Atlantic escort carriers). Similarly, nearly 70 Avengers are still around, of which three served in the Royal Navy and Royal Canadian Navy. Several existing US Navy Avengers may have served in the Atlantic.

Pima Air and Space Museum has a Canso painted in the colours of RCAF No. 5 Squadron, which participated in the Battle of the Atlantic out of Newfoundland. The museum collection contains one of North America's most extensive breadths of aircraft serving in the Battle of the Atlantic. (James Stemm, PASM)

FURTHER READING

The air phase of the Battle of the Atlantic, especially as it relates to Coastal Command and the US Navy's submarine-hunting aircraft squadrons, was largely forgotten by historians until the 1990s. It was treated only peripherally in the official histories of the Royal Navy (Roskill), the US Navy (Morison) and RAF (Richards). In 1992, Chris Ashworth's *RAF Coastal Command 1936–1939* (Patrick Stephens Limited: Yeovil, Somerset, 1992) and in 2006 Andrew Hendrie's *The Cinderella Service: RAF Coastal Command 1939–1945* (Pen & Sword Aviation: Barnsley, South Yorkshire, 2006) appeared. I relied heavily on both for Coastal Command's story. The Fleet Air Arm's role I pieced together from Roskill.

The best book I found for the perspective of the U-boats during this period was Clay Blair, Jr's two-part collection: *Hitler's U-boat War: The Hunters, 1939–1942* (Random House: New York, NY, 1992) and *Hitler's U-boat War: The Hunted, 1942–1945* (Random House: New York, NY, 1992). It is comprehensive, and does not romanticise the U-boats. I also highly recommend uboat.net as the best online collection about the U-boat war.

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A pipe-smoking Sunderland captain receives message from his radio man, a picture illustrating the changes over the last 70 years, in terms of hardware and attitudes. (AC)

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OSPREY PUBLISHING
Bloomsbury Publishing Plc
PO Box 883, Oxford, OX1 9PL, UK
1385 Broadway, 5th Floor, New York, NY 10018, USA
E-mail: info@ospreypublishing.com
www.ospreypublishing.com

OSPREY is a trademark of Osprey Publishing Ltd

First published in Great Britain in 2021
This electronic edition published in 2021 by Bloomsbury Publishing Plc

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A catalogue record for this book is available from the British Library.

ISBN: PB 9781472841537; eBook 9781472841544;
ePDF 9781472841513; XML 9781472841520

Maps by www.bounford.com
Diagrams by Adam Tooby
3D BEVs by Paul Kime
Index by Fionbar Lyons
Typeset by PDQ Digital Media Solutions, Bungay, UK

Osprey Publishing supports the Woodland Trust, the UK's leading woodland conservation charity.

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Author's note:
The following abbreviations indicate the sources of the illustrations used in this volume:
AC – Author's Collection
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USAAF – United States Army Air Force
USNHHC – United States Navy Heritage and History Command

Author's acknowledgements:
I would like to thank James Stemm of the Pima Air and Space Museum for his help with images.

Author's dedication:
This book is dedicated to Tom Milner, the editor of this book and many others I have written. He has allowed me to turn many of my crazy ideas into books since we started working together. Thanks Tom.